Monitoring & logging of VHF beacons using “Spectrum Lab”

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1. Introduction

For a long time, I’ve been willing to automate the monitoring of the VHF beacons. This is easily possible by mean of the very fine piece of software named “Spectrum Lab”, written by Wolfgang, DL4YHF. In brief, that software is an audio spectrum analyser.
The goal of this document is not to give too much explanation about the whole software (the topic is so wide) but more to provide the configuration steps to achieve the defined target. If one wishes more explanation about the working of the software, one would refer to the extensive on-line help available here : http://freenet-homepage.de/dl4yhf/speclab/index.htm.
In the present case, the aim is to deliver (export) a text file including the levels (noise & beacon signal) and screen captures. The topic has already been covered (see http://freenet-homepage.de/dl4yhf/speclab/beacons1.htm) but I want to propose here a more global setup procedure, completed by concrete reception examples.

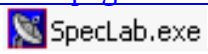
2. System

For information (for the system requirements, see the on-line help), I use a computer with the following characteristics :

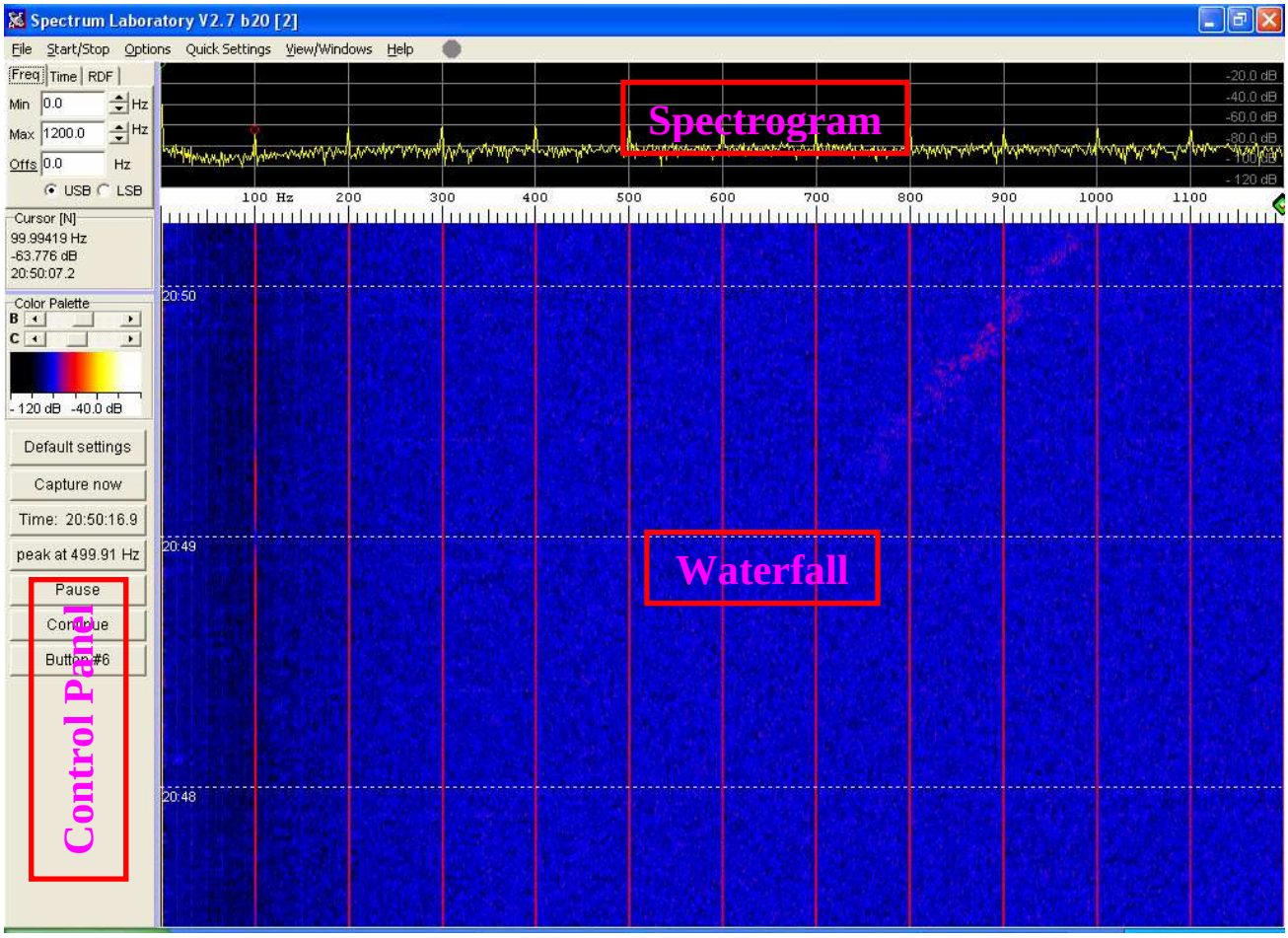
- Pentium IV 3 GHz
- 512 MHz RAM
- On-board 16 bits AC’97 soundcard
- “Spectrum Lab” V2.70 b20

Though the AC’97 soundcard has a limited dynamic range, the goal here is to monitor weak signals and I’ve found it to be more than sufficient. I have a much better soundcard but it is dedicated to my SDR (Software Defined Radio).

3. Configuration steps of “Spectrum Lab”

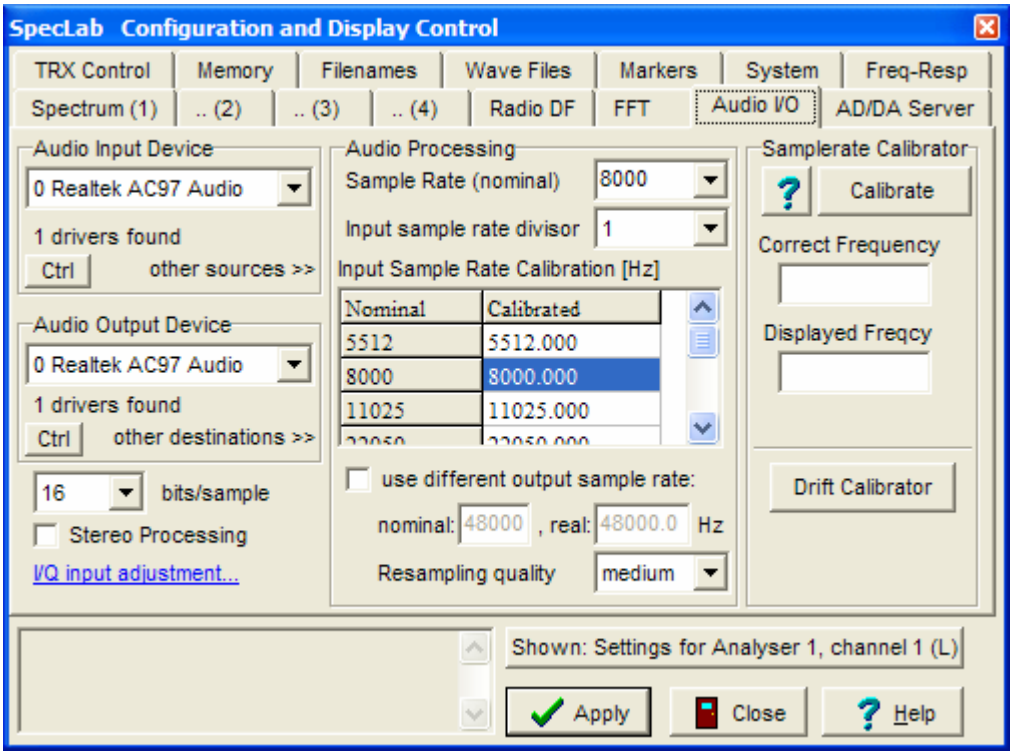
First download and install “Spectrum Lab” from here :
http://freenet-homepage.de/dl4yhf/spectra1.html
Then execute 

, it will appear like on the next page.



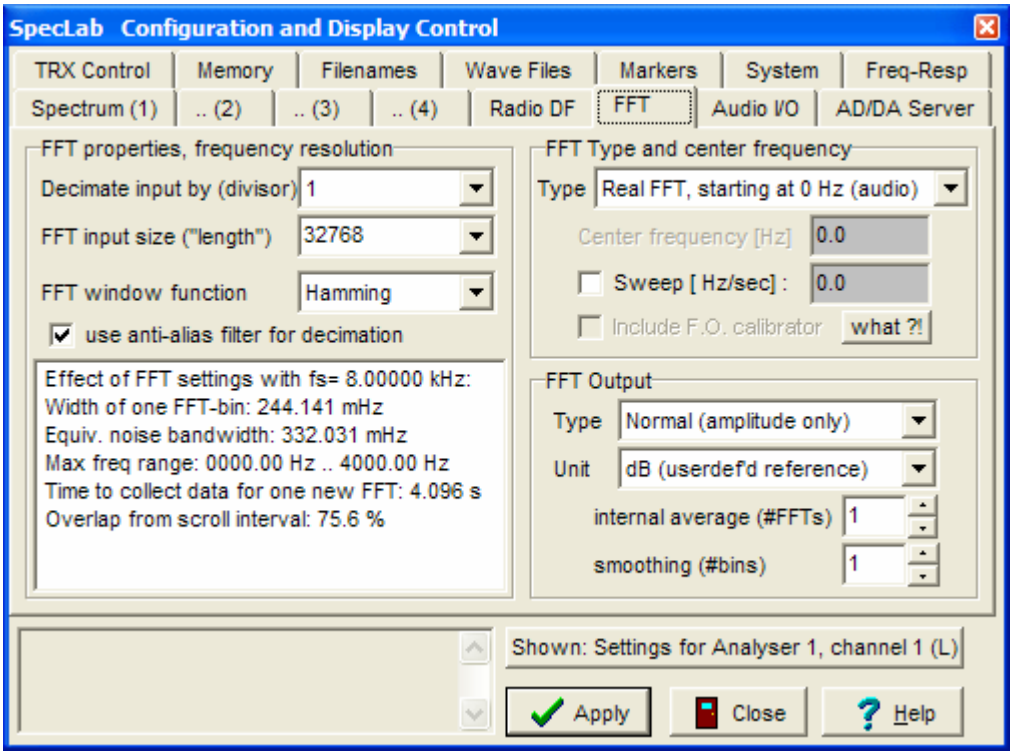
3.1. Audio settings

Go to the menu ***Options*** > ***Audio settings*** and adjust the parameters as on the following screenshot. Obviously, the name of your soundcard can be different than mine (Realtek AC97 Audio).
Clic on ***Apply*** and close the window.



3.2. FFT settings

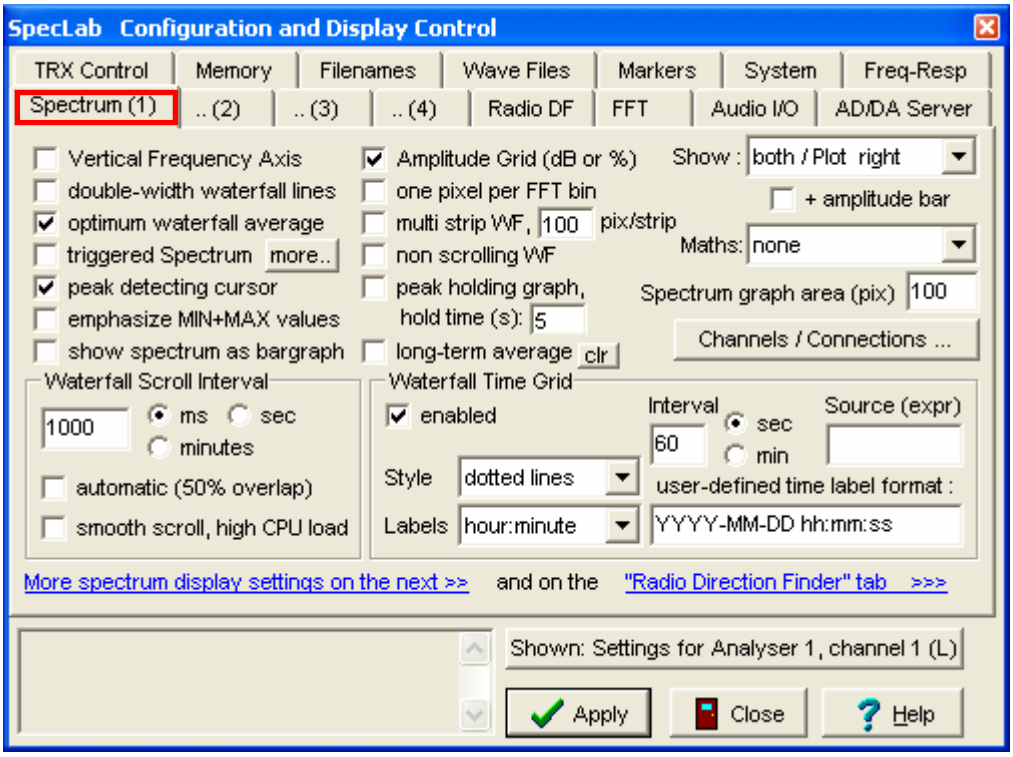
FFT stands for “Fast Fourier Transform”, it is a mathematical tool that allows to transform the time-domain to the frequency-domain.
Go to the menu ***Options*** > ***FFT settings*** and adjust the parameters as on the following screenshot.

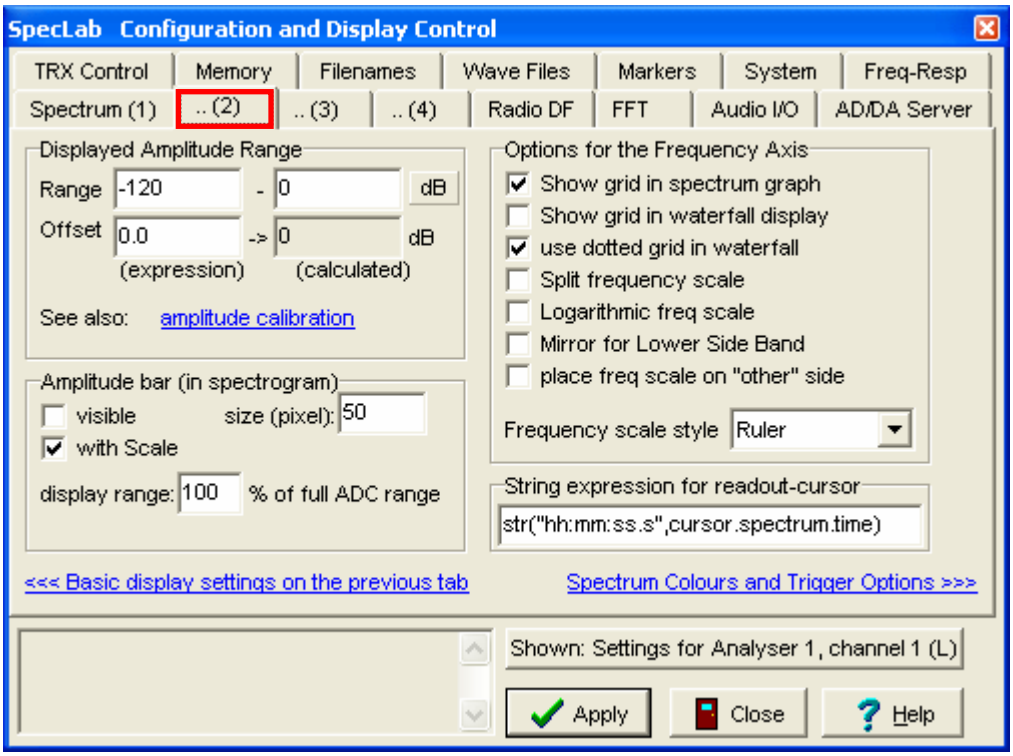


Clic on ***Apply*** and close the window.

3.3. Spectrum display settings

Go to the menu ***Options*** > ***Spectrum display settings*** and set the parameters. The setting lies on two different tabs (see the red rectangles below) :

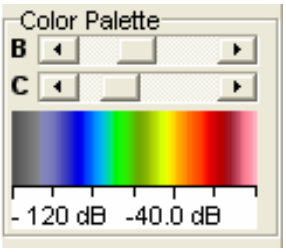




On both windows, clic on ***Apply*** and close the window.

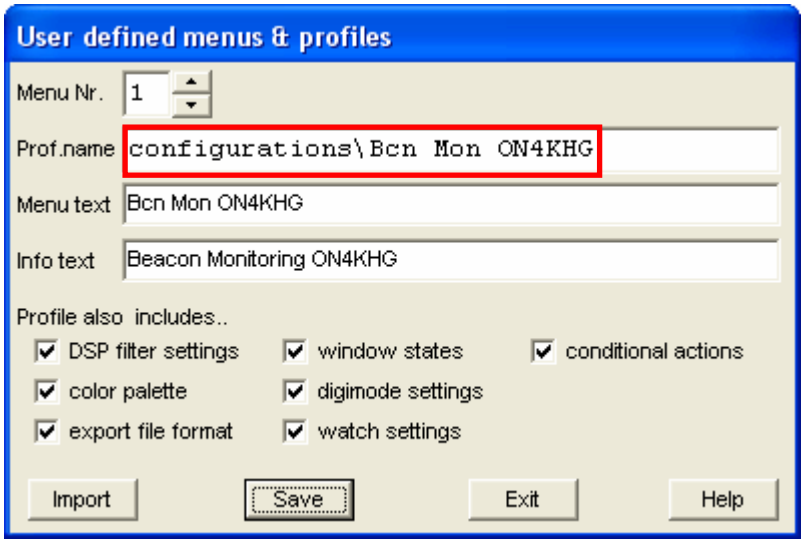
3.4. Waterfall color palette

Go to the menu ***File*** > ***Waterfall Color Palette*** > ***Select from list***
You select the color palette you want and on left side control panel of the main screen, adjust the Contrast (C) & Brightness (B) as you wish. In my case, it appear like this :



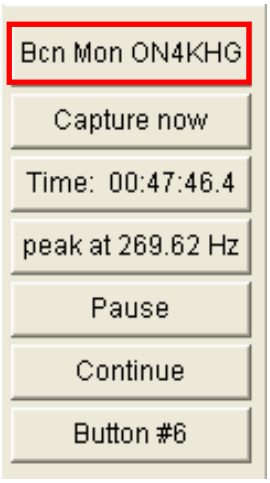
3.5. Saving the configuration

Go to the menu ***Quick Settings*** > ***Load & Create user defined entries*** and you get the window below :

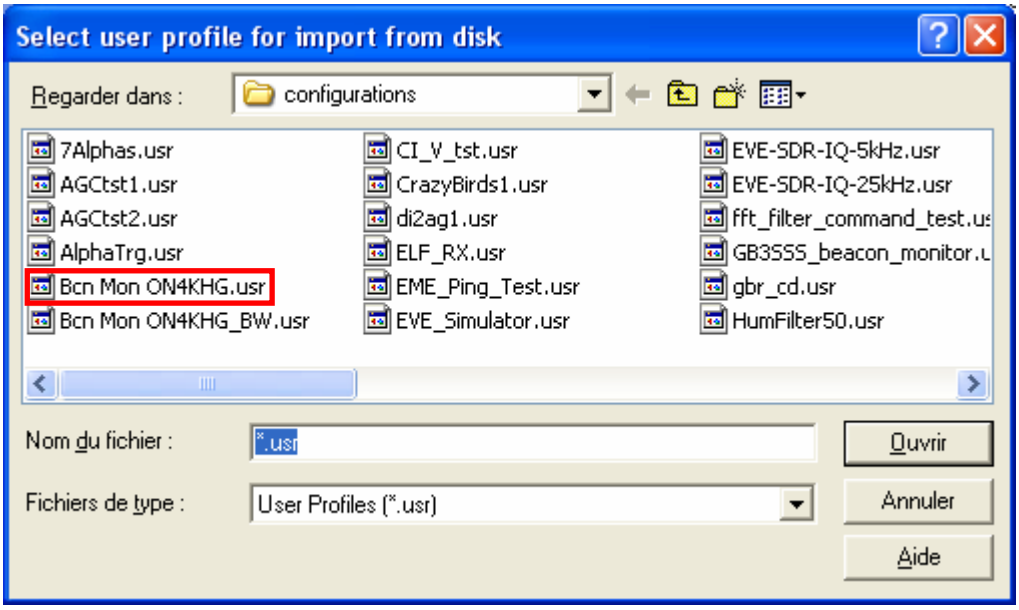


In the ***Prof.name*** field (highlighted by the red rectangle here above), you enter the path where your configuration will be saved (here the subdirectory ***configurations***) and you name it : "Bcn Mon ON4KHG" in my case but of course up to you to give any other name.
The two other fields below (***Menu text*** & ***Info text***) are informative.
Then you clic on ***Save***.

If you go to the menu ***Quick Settings***, your configuration now appears below the line ***Load & Create user defined entries***. And on the left side control panel of the main screen, it looks like :



When executing "Spectrum Lab", you can now load your configuration by going to the menu ***Quick Settings*** > ***Load & Create user defined entries*** > ***Import*** and select the file ***Bcn Mon ON4KHG.usr*** (or the name you have given.usr) from where you have saved it :



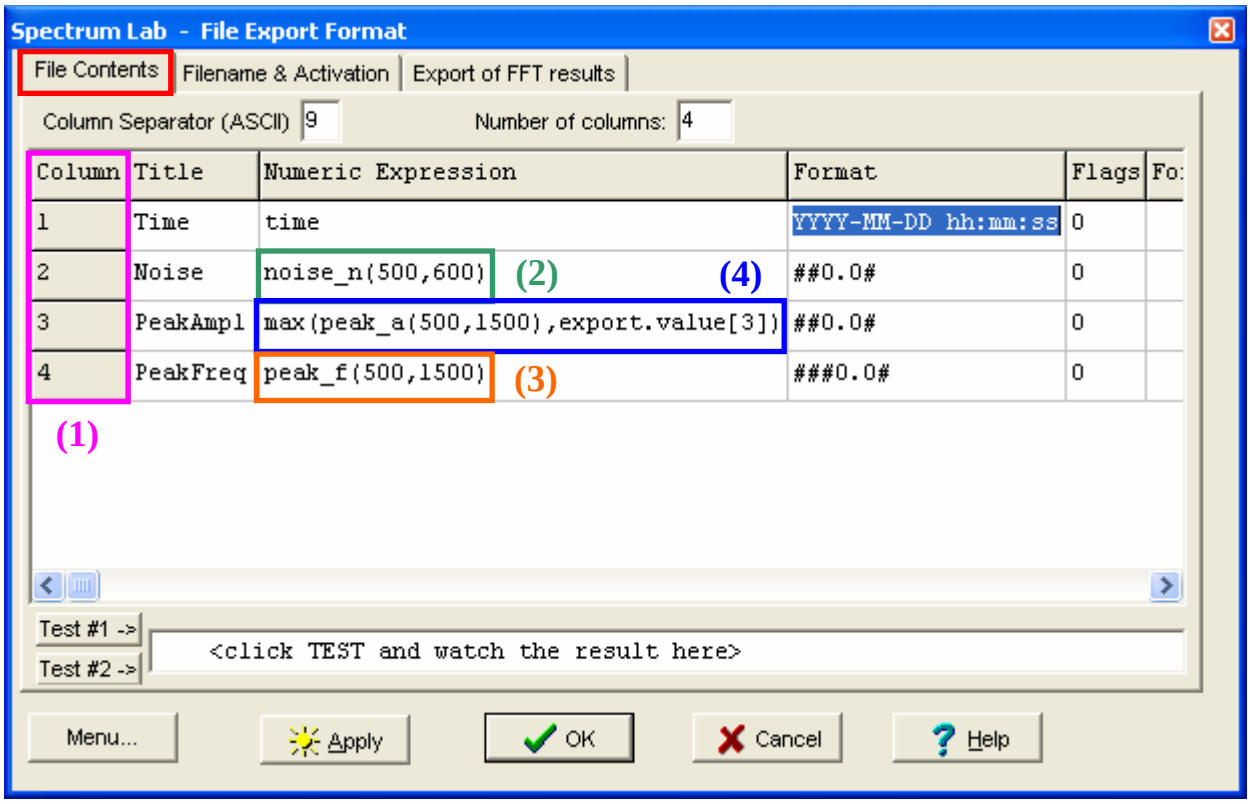
The file ***Bcn Mon ON4KHG.usr*** is provided in the compressed (.zip) file including the present document.

4. Creation of export files & screen capture

Now that "Spectrum Lab" is configured, it is now time to define the instructions needed to create the export files & screen captures of the beacon to be monitored.

4.1. Export files

Go to the menu ***File > Text file export > Export of calculated data***.
In the tab ***File Contents***, type the expressions in, as in the following ***definition table*** below.



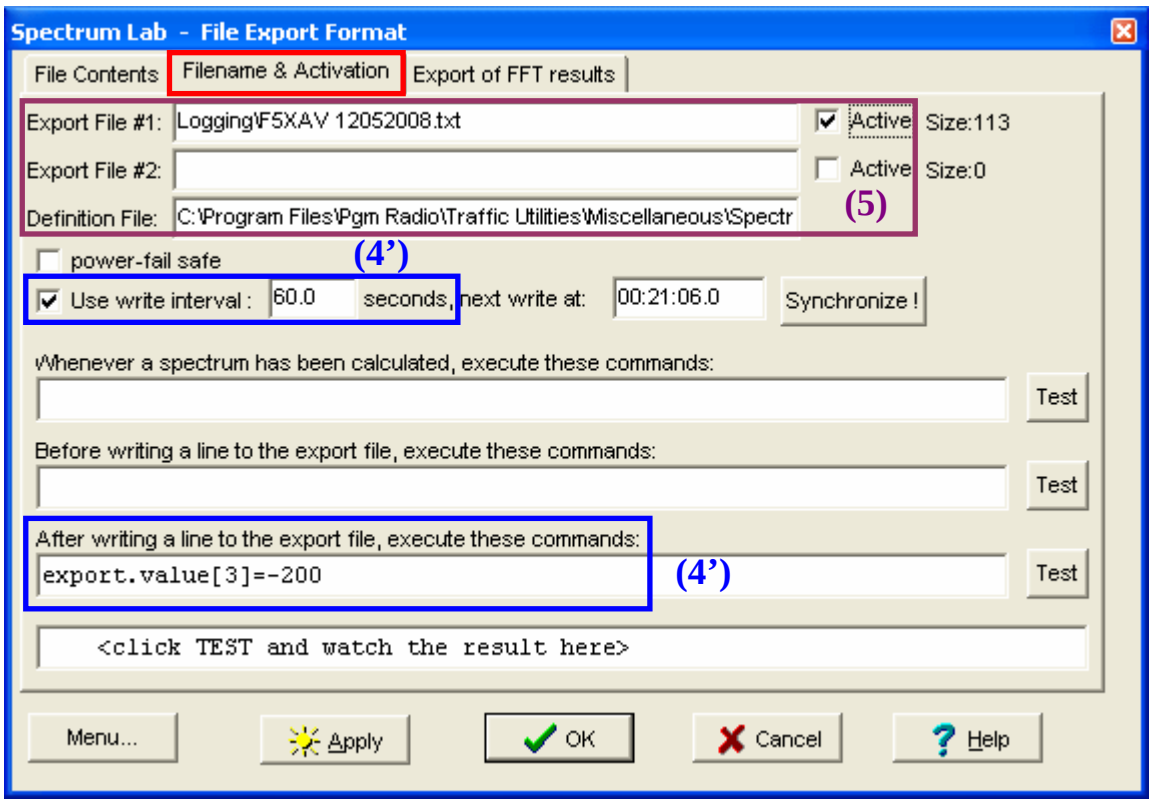
(1) The first line of the definition table (***Time***) corresponds to the first column in the file to be exported. And so on for the other lines.

(2) This expression returns the noise level, normalized to 1 Hz (this makes the measurement independent of the FFT setting) and measured between 500 Hz and 600 Hz. These frequencies and the associated span are not too much important but to guarantee the measurement accuracy, make sure there is no birdy nor the beacon signal included in that frequency range.

(3) This line instructs the software to write the frequency of the peak signal detected (still between 500 Hz and 1500 Hz) in the fourth column of the export file. This is informative

(4) Here, the peak value of the signal of interest is measured every second, within a 1 kHz bandwidth, between 500 Hz and 1500 Hz (into which the beacon to be monitored will be tuned). The value is saved as a variable (but not "written" to the export file yet ; see 4' below) in the third column (purpose of the ***[3]*** in the expression) of the export file and compared to the next one. Between the two, the highest value (max) is retained. And so on repetitively, in every 1 s interval.

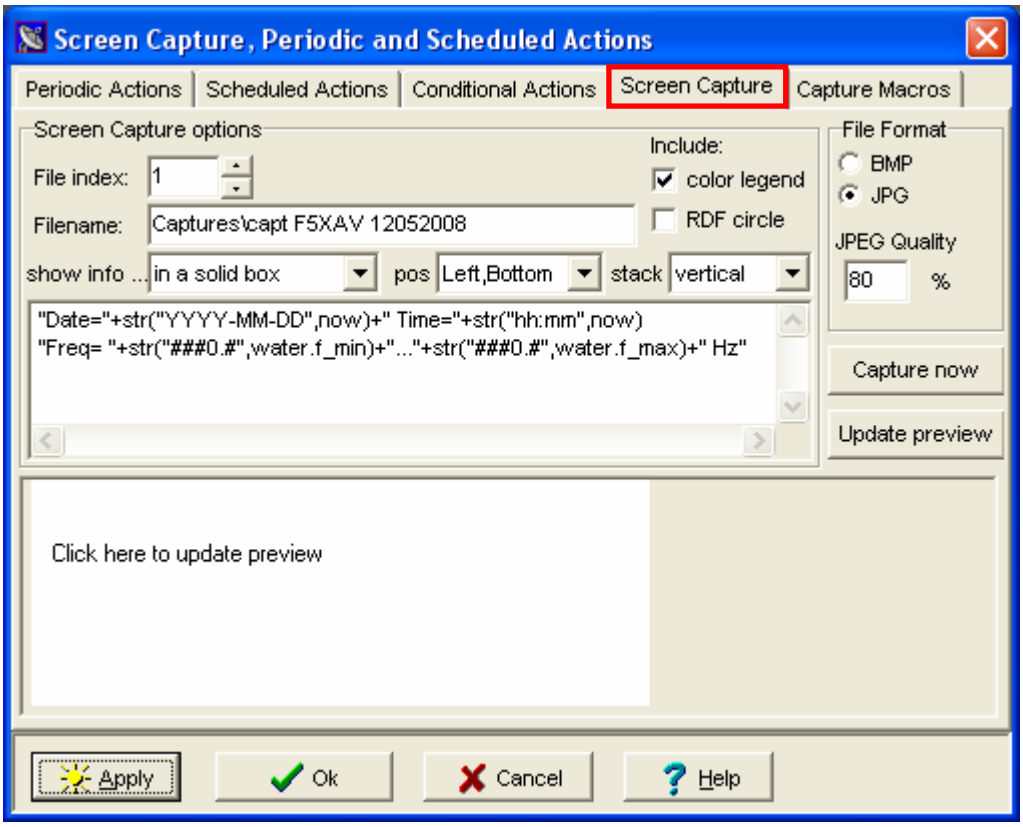
(4') Then, in the second tab of the same window, you instruct the software to effectively write the peak value into the export file every 60 s. After the value has been written into the export file, the measurement is reset to -200 (to be seen as "zero") and the peak measurement cycle can start again for the next 60 s. This is shown on the next screenshot.
Within a 60s measurement cycle, it is likely the beacon is transmitting a continuous carrier onto which the peak amplitude level can be measured.



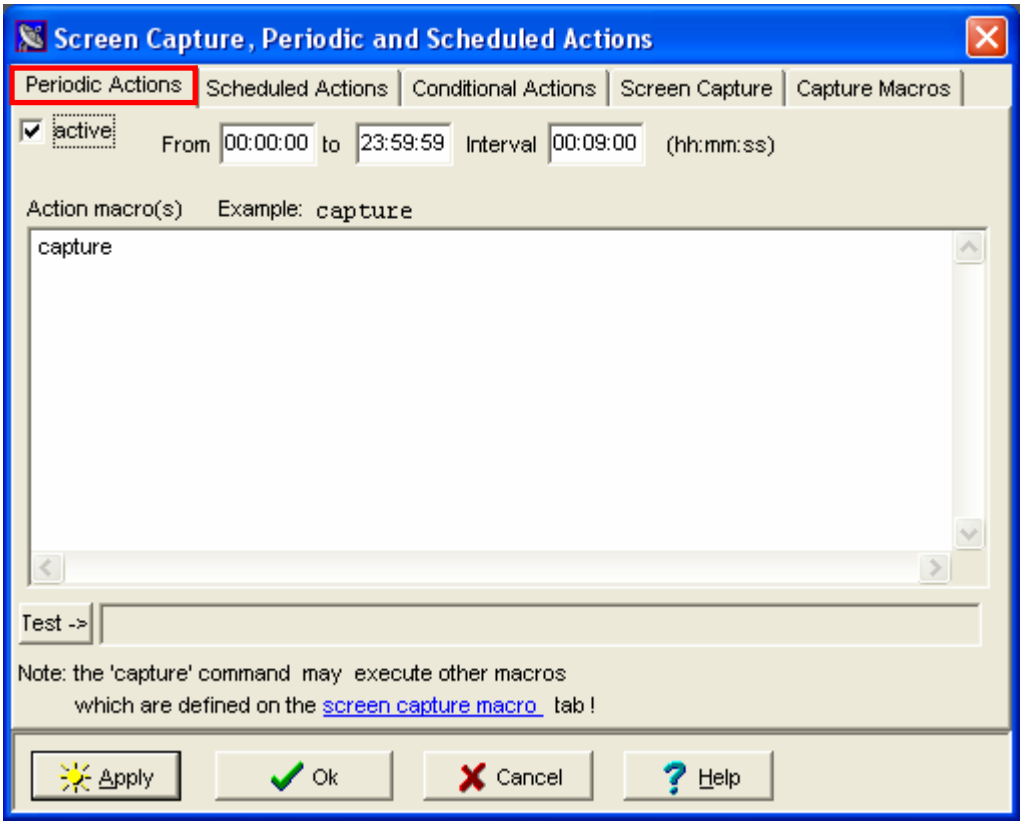
(5) At the first line (***Export File #1***), you set the path where to save the export file (in the present case the subdirectory ***Logging***) and you give a name to your file. Then, check the box ***Active*** to activate the export.
At the line ***Definition File***, it is the path where your configuration file (here ***Bcn Mon ON4KHG.usr***) is stored.

4.2. Screen captures

Go to the menu ***File > Screen Capture > Screen Capture options***.
In the tab ***Screen Capture***, at the line ***Filename***, you define the subdirectory (here ***Captures***) where to save the screen shots and you give them a name (here ***capt F5XAV 12052008***). The field ***File index*** will be incremented by one unit after a screen shot has been saved ; this index is added at the end of the screen shot name.
Up to you to define the file format, quality and if you need a color legend on your screen captures.



In the tab ***Periodic Actions*** of the same window, you define the time frame during which you wish to make screen captures (here ***From 00:00:00 to 23:59:59***) and the interval between two captures. With the settings given in the present document and with my computer, it takes around 9 min to scroll down a full waterfall.
The ***Interval*** between two captures has then been set to ***9 min***. Finally, clic on the ***active*** checkbox to make effective the screen capture feature.



You can now update the full configuration (***Bcn Mon ON4KHG.usr***) with the settings related to the export file and screen capture.
To do it, go to the menu ***Quick Settings*** > ***Load & Create user defined entries*** and save the updated configuration.
Be careful that by checking the appropriated checkboxes, you have activated the file export and screen capture and saved the configuration file (.usr) accordingly.
So, when launching "Spectrum Lab", the software will start automatically to export a file and capture screen shots. To avoid this, update the configuration file with the ***Active*** checkboxes unchecked and activate de feature manually at any time when "Spectrum Lab" is open.

5. Receiver settings

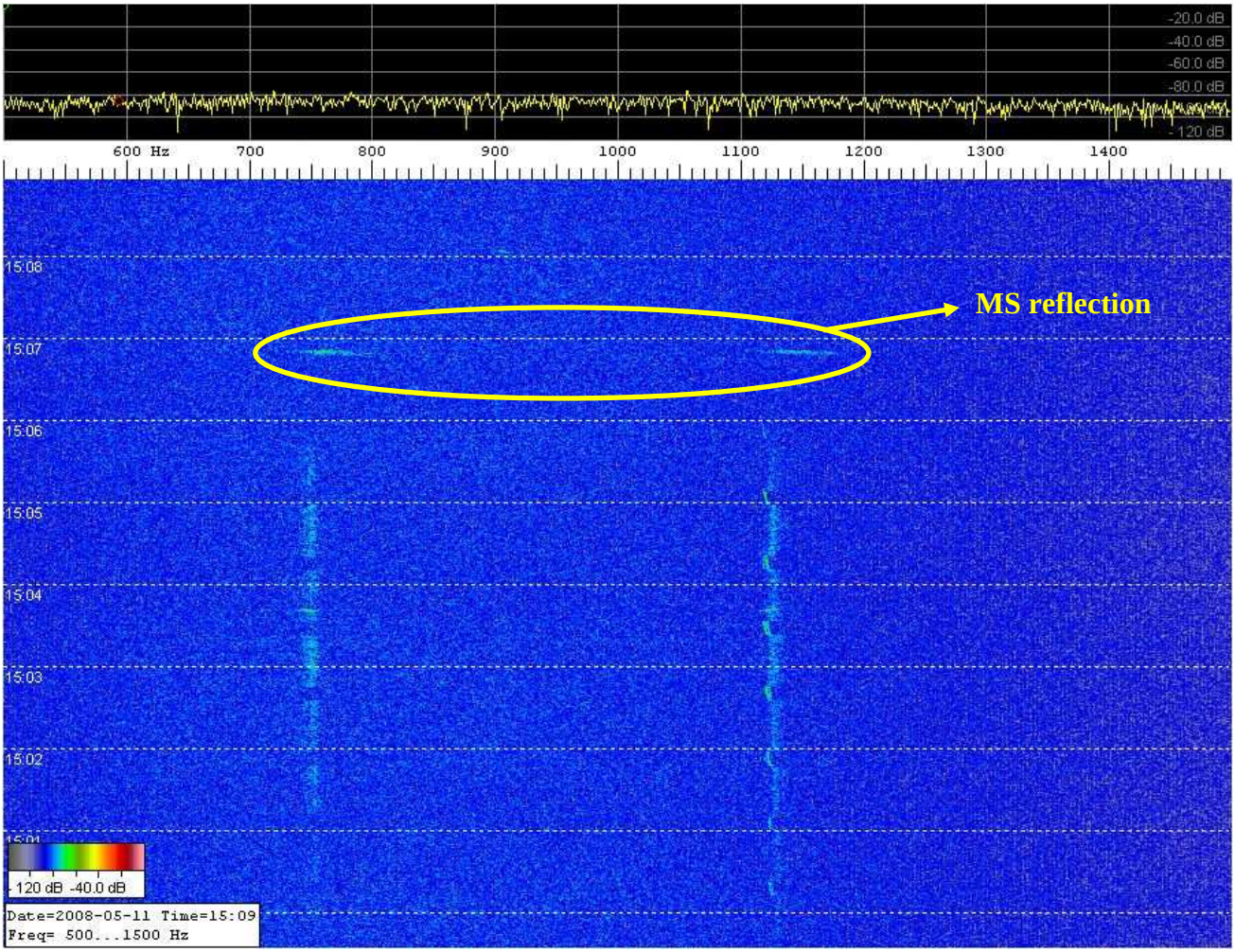
Preferably ***deactivate the AGC*** if possible or set it on the "Fast" position but this last will affect the accuracy of the measurement.
Adjust the audio volume at the input of the soundcard (***Line IN***), so that the ***spectrogram*** of "Spectrum Lab" shows a ***noise floor of -90 to -100 dB*** ; with a better soundcard, you can descend below that value.
In order to avoid noise cracks, it is wise to ***activate de NB***.
Better use an interface with galvanic isolation (600:600 transformer) between your receiver and the computer.

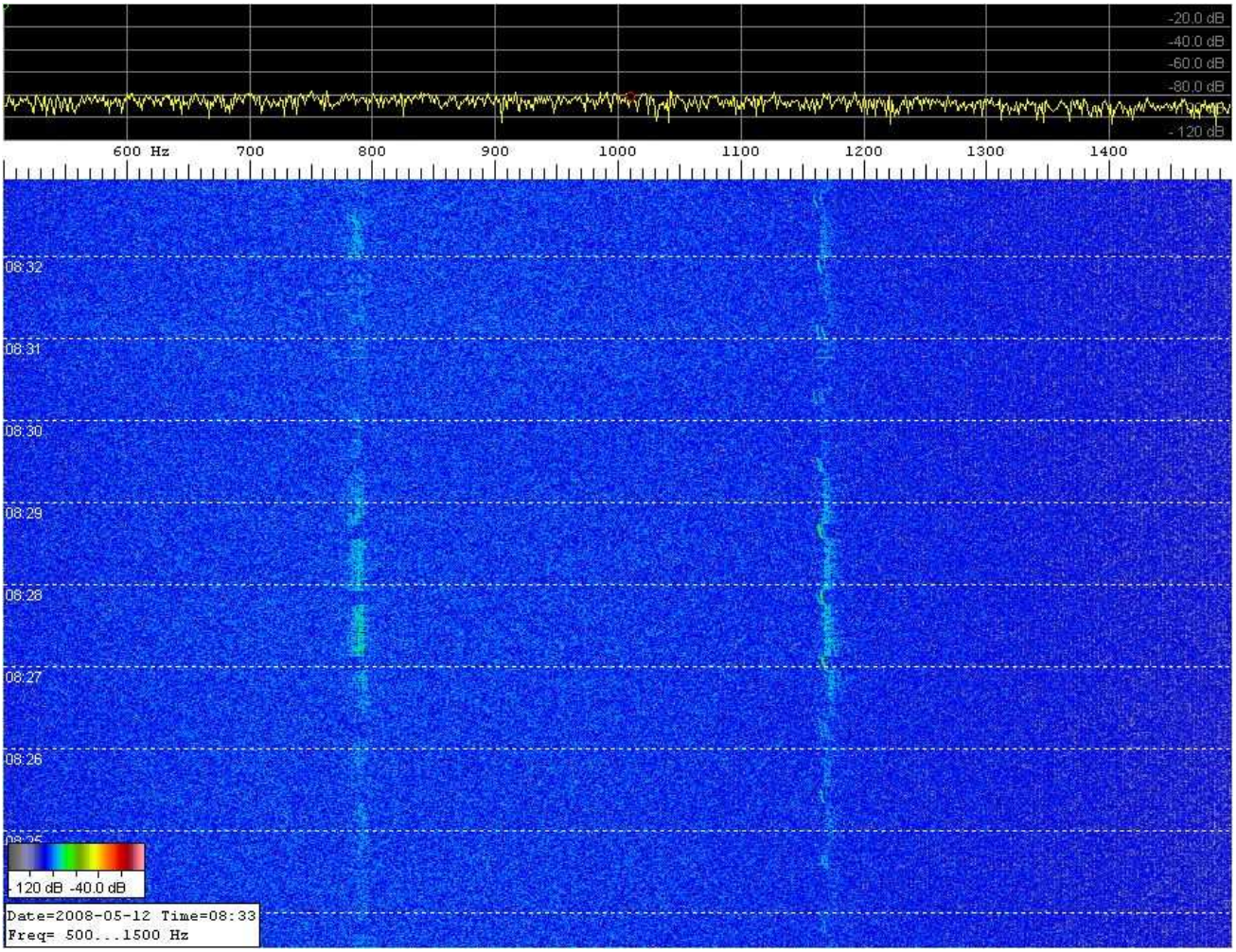
6. Examples

6.1. Reception of F5XAV

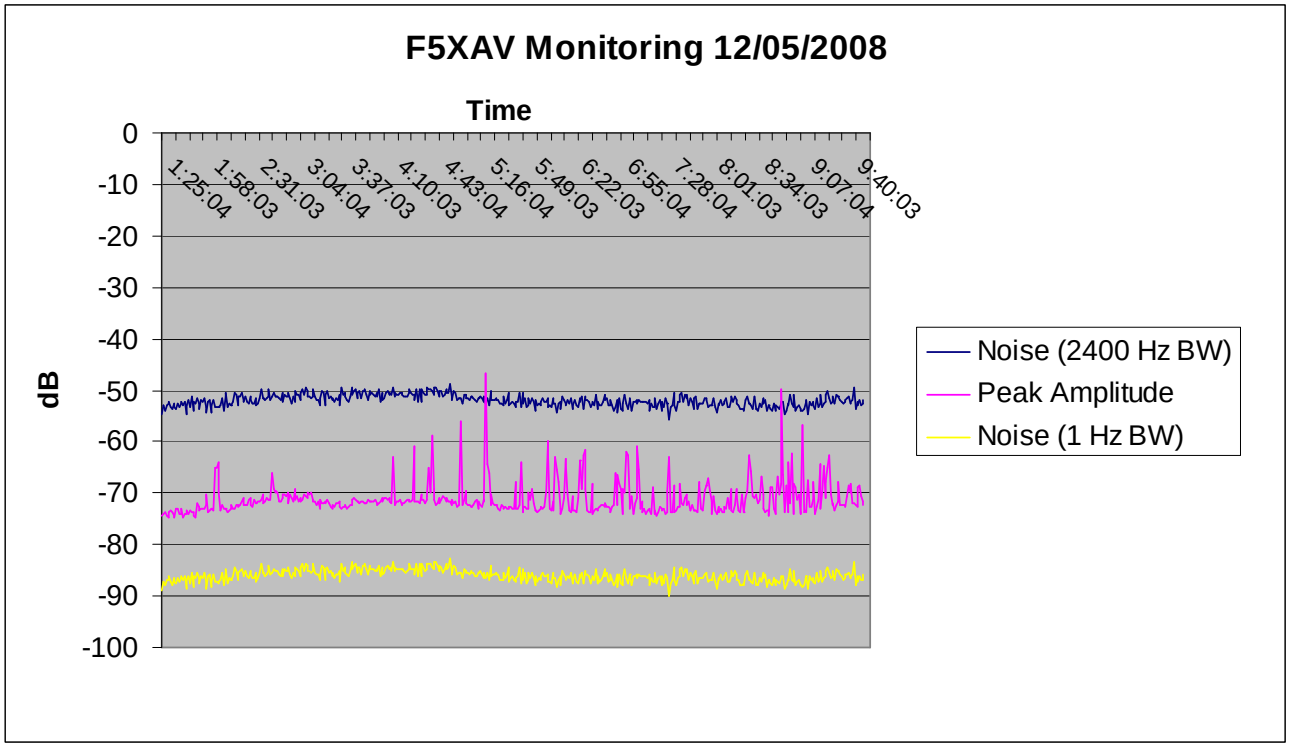
F5XAV, QRG 144.450, “Balise du Pont du Gard” is located in JN24GB (QRB 729 km from my locator JO10XO), has around 10W ERP.

A few screen shots of its reception at my station can be seen below.





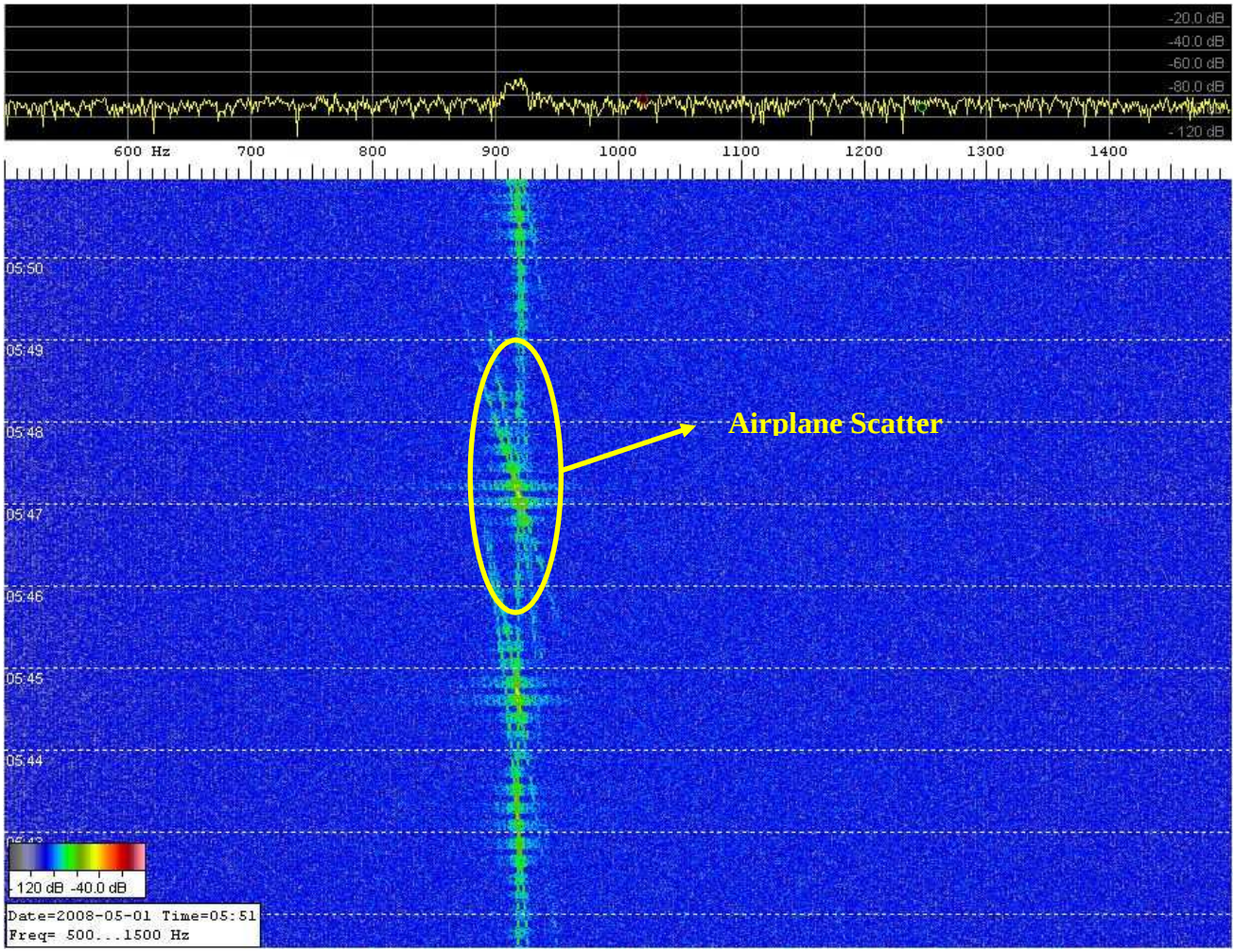
From the screen shots above, one can see the FSK modulation, with a short unmodulated continuous carrier.
When processing the export file (.txt) in Excel, one can get the following graph :



We see the signal of the beacon in purple. The noise floor in a 1 Hz BW (BandWidth) is in yellow and the noise floor in a standard 2400 Hz SSB BW is in blue. It is calculated out of the 1 Hz one, buy adding 10*log(2400) = 34 dB.
At two occurrences only the level of the beacon has exceeded the 2400 Hz BW noise floor. However, thanks to the “DSP” capabilities of the brain, a human ear can hear a signal that is up to 10 dB below the standard SSB BW noise floor. According to the graph above, this occurred some times during the monitoring duration.
We also see that the noise floor has varied by a few dB’s during the monitoring period, due to the man-made noise change and/or the temperature variation on the electronic components of the receiving equipment.

6.2. Reception of HB9HB

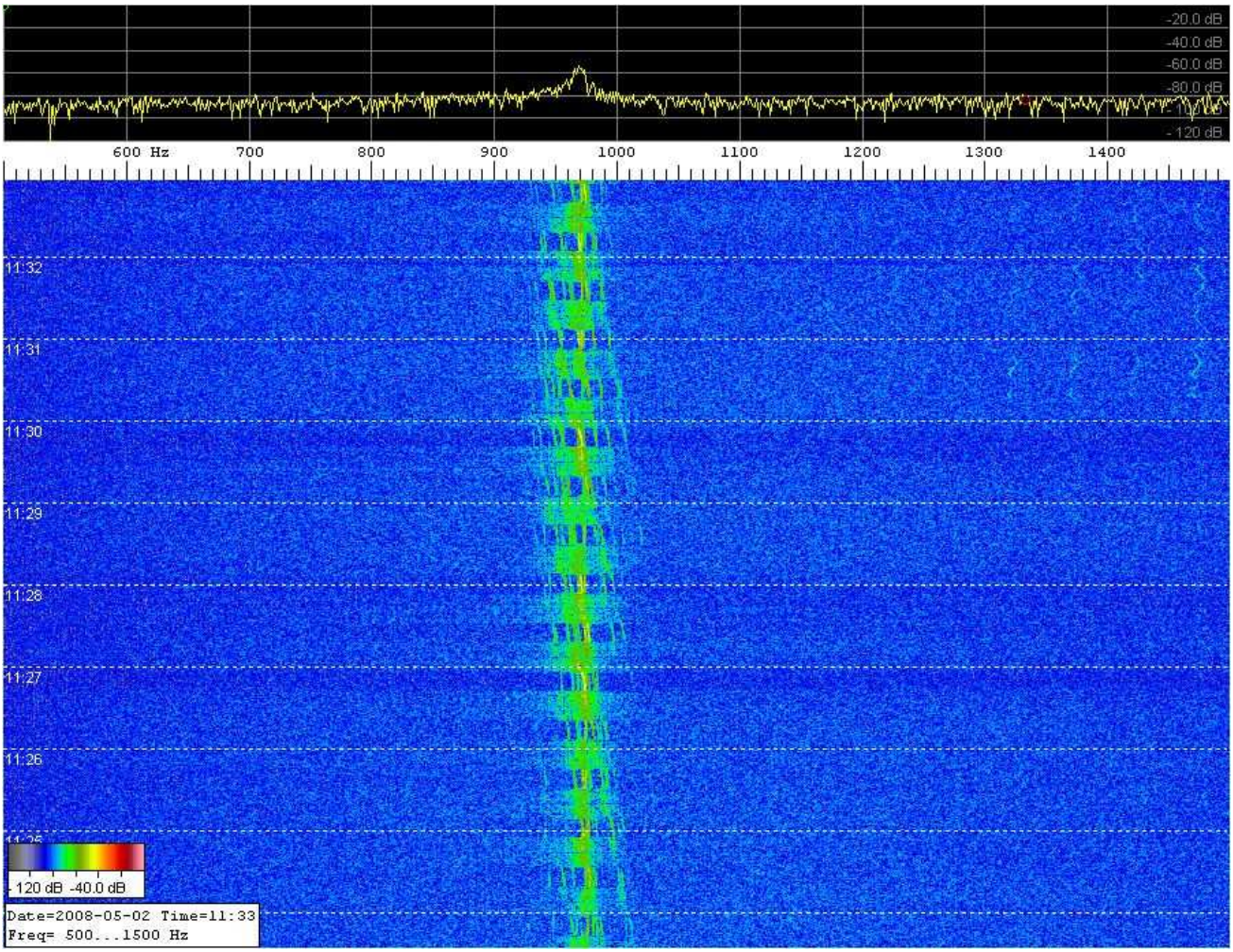
HB9HB, QRG 144.448, is located in JN37OE (QRB 448 km from my locator JO10XO).



We see the signal strength enhancement, thanks to the Airplane Scatter, together with the associated doppler frequency shift.

6.3. Reception of FX3THF

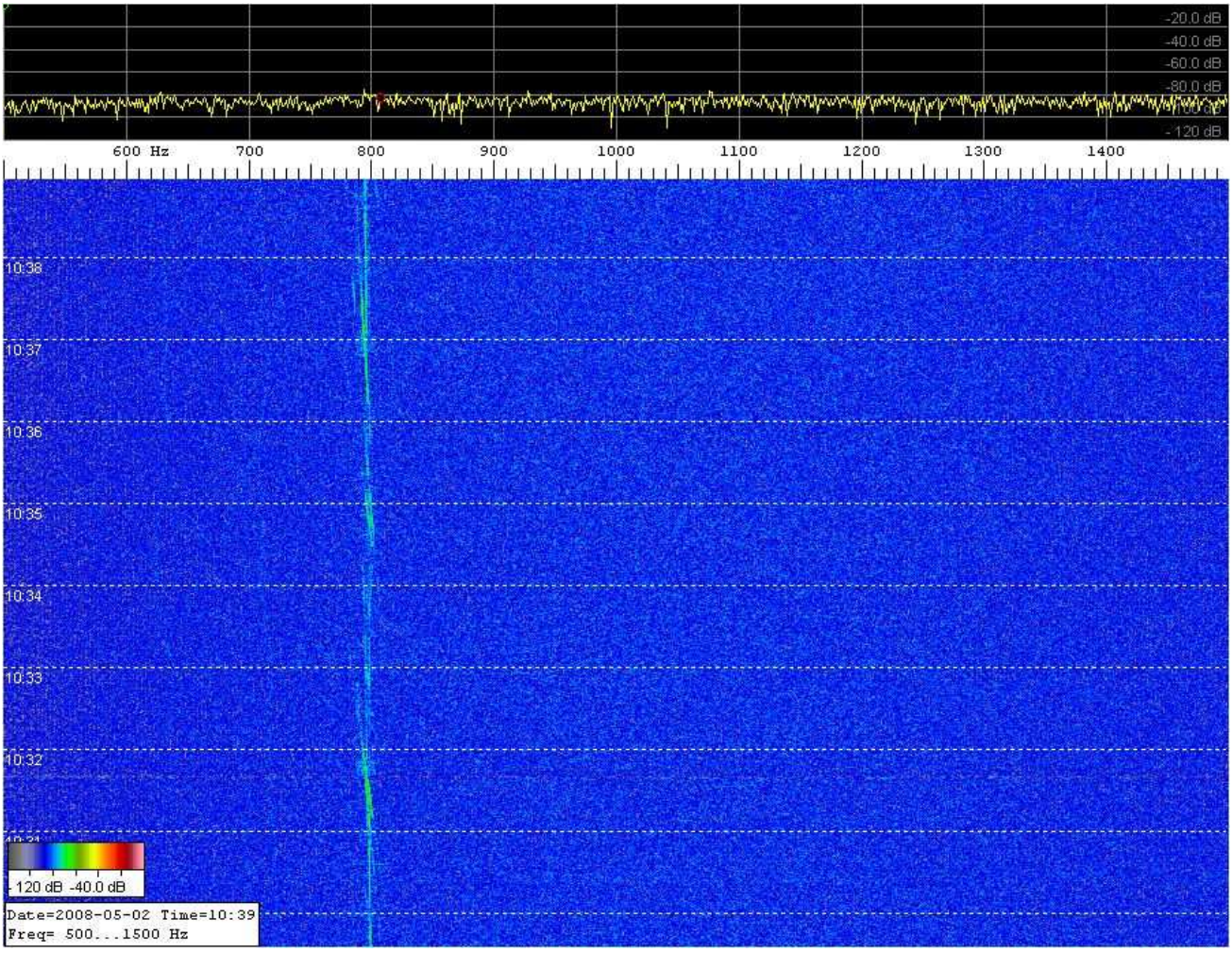
FX3THF, QRG 144.409, is located in IN88GS (QRB 571 km from my locator JO10XO).



Much Airplane Scatter here too.

6.4. Reception of DB0SGA

DB0SGA, QRG 144.475, is located in JN69KA (QRB 664 km from my locator JO10XO).



7. Conclusion

“Spectrum Lab”, written by Wolfgang, DL4YHF is a fantastic software that allows to automate the monitoring of beacons but also many other things (sun noise measurement, man-made noise measurement, ground gain vertical antenna lobes measurement, meteor reflections counting,…) through very simple tailor-made “programming’.