

What is Argo ?

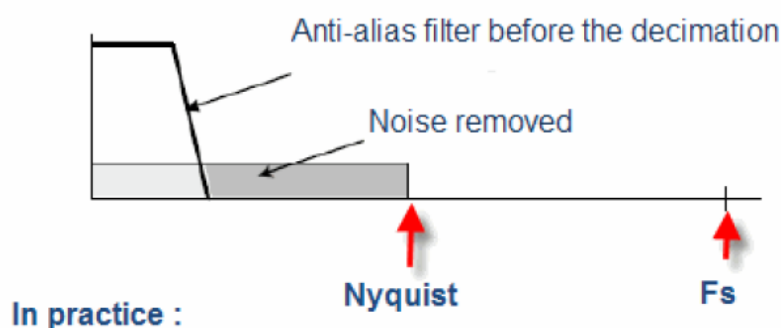
A paragraph like this should be placed at the beginning of every User Guide...instead very often the Guide starts with describing the changes from the previous version, leaving the first-time user perplexed about what the program can do.

Argo is a Windows software that when fed with a signal from a sound device (either internal or external to the PC) can show its waterfall and optionally its spectrum with a resolution selectable by the user that can go from just slightly more than 1.5 Hz down to about 45 μ Hz, that is 45 microhertz.

The name Argo is taken from that mythical ship which, with the Argonauts on board, headed to Colchis in the quest for the Golden Fleece, much like the LF Hams are in search of that fraction of dB of S/N which will allow them to make that elusive reception.

This tool was born about 25 years ago, when some more technically-minded radio amateurs started experimenting with very slow CW on the LF and HF bands. It was called CW QRSS to emphasize the really slow nature of the method, where the dot duration could vary from 3 seconds in length, up to even 1200 seconds... of course this kind of very slow CW could not be decoded by ears, it needs to be visually decoded using a waterfall on the screen with a scrolling speed comparable to the dot speed.

Why such a long duration of the CW elements? The physics dictates that. Given the very low EIRP (amount of energy effectively radiated from an antenna that by necessity is quite short with respect to the wavelengths used) the signal received by the remote station is deeply buried into the noise. And to scavenge into the noise you must restrict the bandwidth down to the value used by the signal of interest, leaving so almost all of the noise outside, as shown in this figure.



$$\text{SNR} = (6.02N + 1.76) + 10 \cdot \log_{10}(F_s/F_d) \text{ dB}$$

where F_s is the ADC sampling rate, and F_d the rate after the decimation.
 N is the number of bits of the ADC.

The lowpass filter should be just wide enough for the signal of interest, but no more...

And what is implied by all of the above is that as a more fine resolution is needed, the more time you need to fill the FFT buffer... As a matter of facts, the resolution (size of the FFT bin) is given by the sampling frequency divided by the buffer length. So, for example, when you set Argo for the QRSS60 mode (which means that the duration of a dot is 60 seconds), with a sampling frequency of 6 kS/sec, you obtain a bin size of 11.44 mHz (millihertz...) and an FFT buffer size of 524288 samples. To fill such a buffer with 6000 samples per second, you need $524288 / 6000 =$ slightly more than 87.38 seconds... there isn't such a thing as a free lunch... the more resolution you need, the more time you have to wait...

The 6 kS/s final sampling frequency reported above is valid only for resolutions down to 715.26 μ Hz (QRSS 1200). For the three finer resolutions (356.6, 178.8 and 44.7 μ Hz) the final sampling frequency is 375 S/s. Except for the Base Band, the frequency specified in the Freq.Range menu is downconverted to 150 Hz. (Don't confuse downconversion with downsampling...)

Resizing it

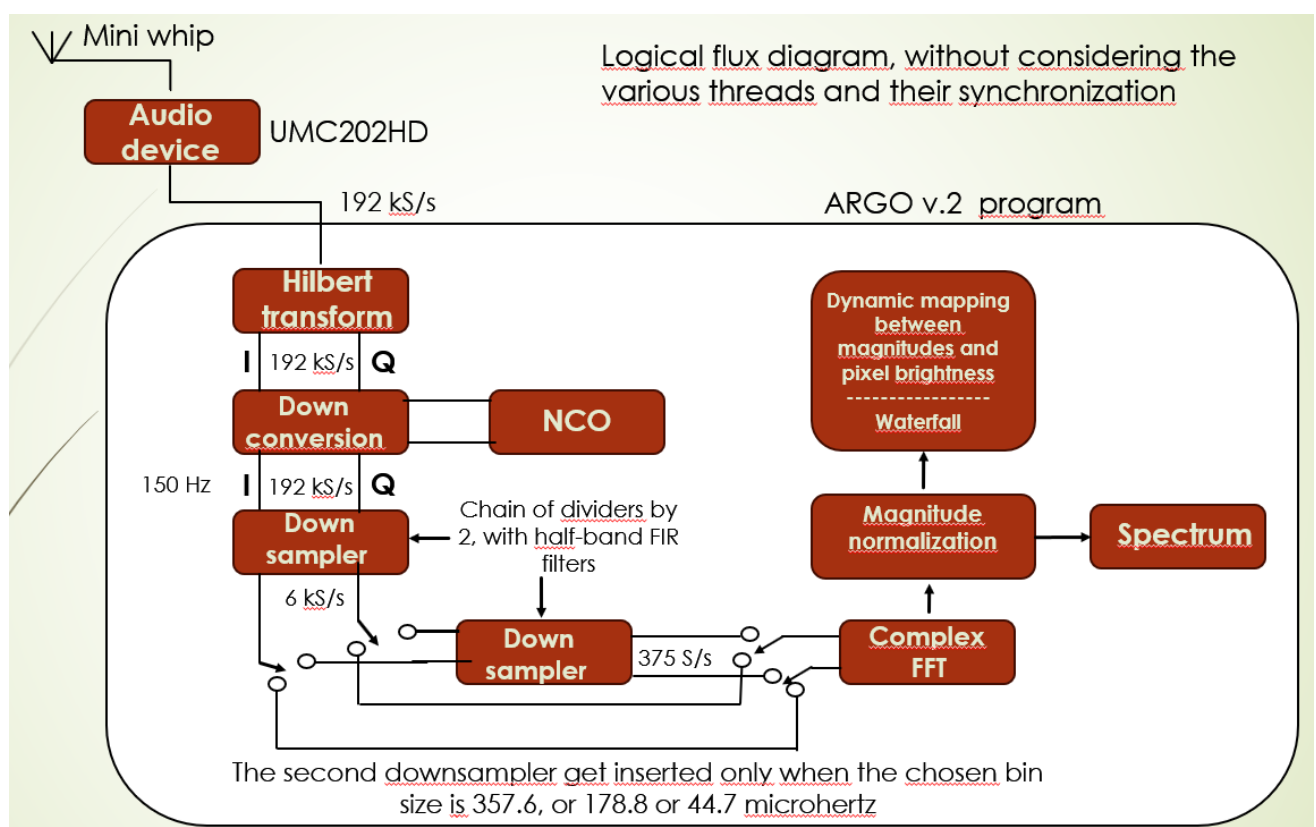
The horizontal size of the main window of Argo is fixed. The vertical size is adjustable within limits by using the + and the – keys, either on the numeric keypad or on the main keyboard.

The ESC key clears the waterfall. The Spectrum window has fixed dimensions.

Note : Argo is optimized for a screen resolution 1920 x 1080

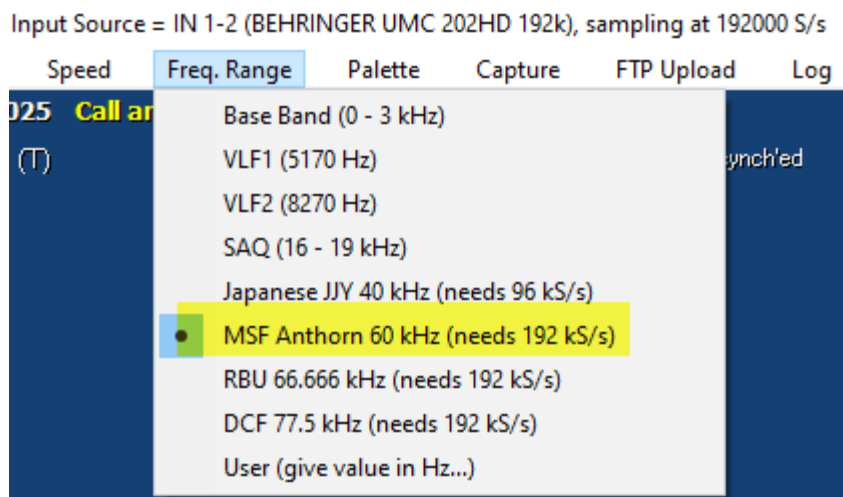
How does Argo operate ?

Before delving deeper in the innards of Argo, it might be useful to show a simplified view of its architecture. Here the relations between threads and their synchronization have been omitted, showing just the logical flux. In this diagram it is supposed to send to Argo the output of a mini whip antenna. This is just an example.



You have the choice to feed Argo in base-band (0..3000 Hz), as when using a Virtual Audio Cable, or to send it a signal with a much higher frequency, up to the Nyquist frequency, which is half the sampling rate at which the sound device operates. This second mode can be used, e.g., to receive signals in the VLF or the first part of the LF band, by directly connecting the antenna to the sound device, no radio needed. For example, you can receive the SAQ (17.2 kHz), the MSF or the WWVB in the US (60 kHz), the Russian RBU (66.667kHz) or the DCF77 (77.5 kHz). Of course, provided that the sound device supports the needed sampling rate...

You select the frequency range with this menu choice :



You see here listed also the 5170 and the 8270 Hz choices, which are the frequencies chosen by some state-of-the-art OMs, experimenting with such low values.

When working on base-band the input signal is just downsampled from 48 kS/s down to 6 kS/s, no downconversion is done, and you explore the waterfall and the spectrum from 0 to 3 kHz. As said above, this mode is useful when feeding Argo through a Virtual Audio Cable.

In all of the other modes, in addition to the downsampling, the signal is also downconverted to a center frequency of 150 Hz. So, for example, you will find the 60 kHz of WWVB displayed at 150 Hz. This applies also when selecting the bottom choice of that menu, which allows to specify a custom frequency.

A short note about the base-band operation

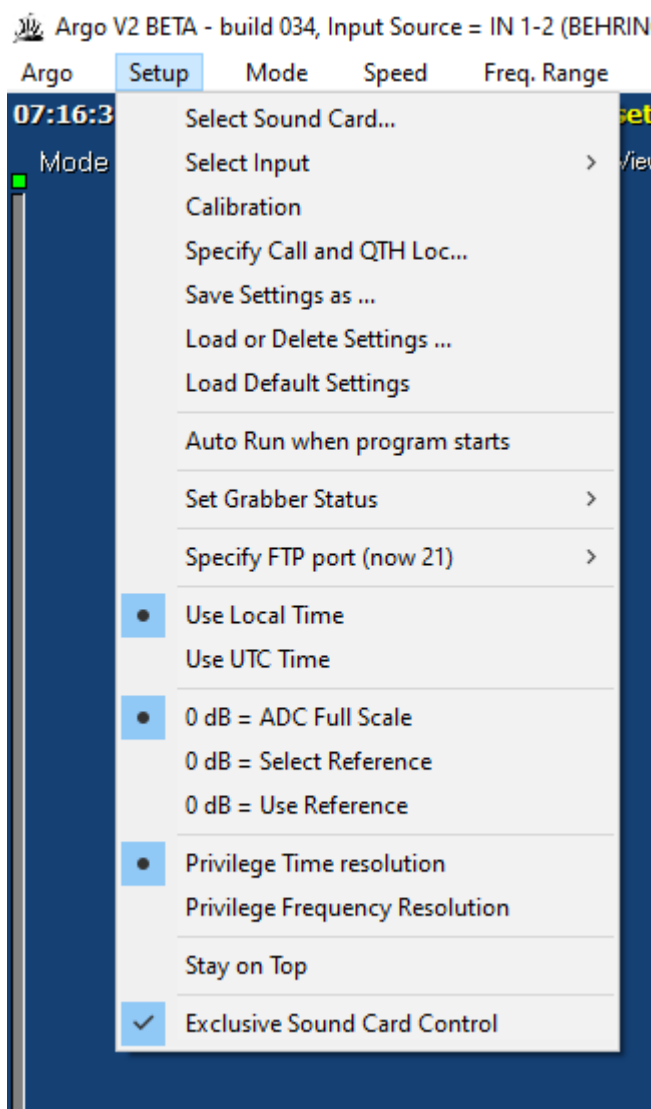
Base-band operation simply means that what Argo expects as input is a signal in the range 0-3000 Hz, be it coming from a microphone, an SDR (maybe through the Virtual Audio Cable), or from any other source able to generate such a signal.

This is as the previous version of Argo (v.1) did operate. In addition to this, Argo v.2 has added the capability to accept signals up to the Nyquist frequency of the digitizing source, allowing the visualization of signals up to 96 kHz, if the signal source (e.g. the sound card) is capable of sampling at 192 kS/s.

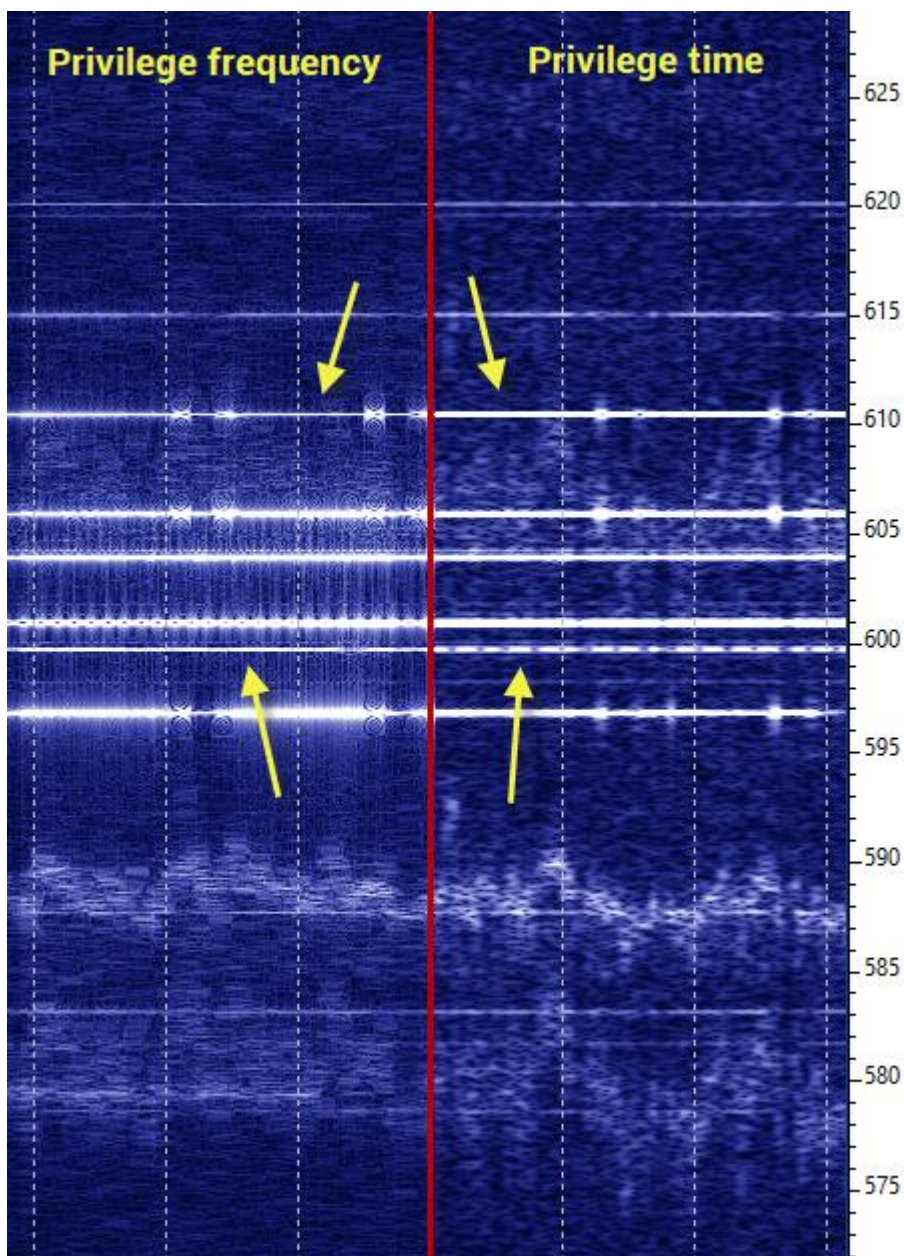
To set Argo in base-band mode, just select "Base Band" in the Freq.Range menu, and deselect the "Exclusive Sound Card control" choice in the Setup menu. Then select the desired signal source in the Setup menu. When not in Base Band mode, always select "Exclusive Sound Card control" in the Setup menu.

The menu structure

The setup menu



Here you can specify the sound device you want to use to feed data into Argo, together with some other almost self-explanatory parameters. The “Privilege Time resolution” is the default and should be changed only for very special needs. The other choice, “Privilege Frequency Resolution” makes the display of Argo more oriented towards showing a finer resolution but at the expenses of rapid variations of the signal. Use it only if you are sure you need it. This is example of both. You will notice a finer line depicted in the left half of the screen, and rapid changes visible in the right half, but blurred in the left half.

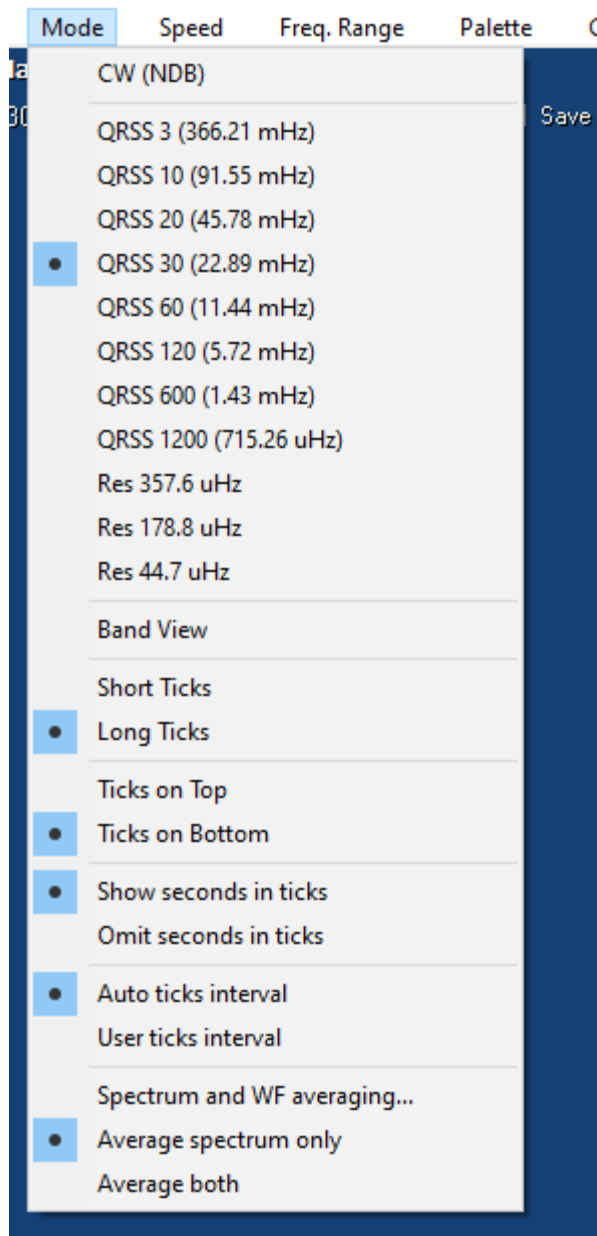


The “Exclusive Sound Card Control” should be unchecked when the base-band option is selected, and checked when one of the other Freq.Range choices is selected. When checked, Argo tells to WASAPI (the sound subsystem of Windows) that it wants to have exclusive control of the sound device, setting the sampling rate as it is needed, and no other program is allowed to use at the same time the selected sound device.

So, when using the VAC (Virtual Audio Cable) and desiring to route the audio stream coming, for example, from an SDR to some other programs besides Argo, that choice must be unchecked.

Other choices in the Setup menu allow to save all the current parameters of the program with an user-chosen name into an .INI file, reloadable at will in a future session.

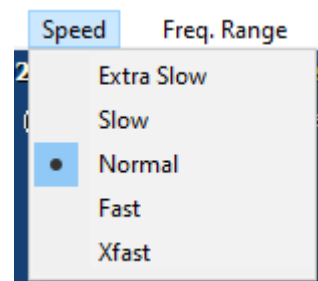
The Mode menu



Here you can select the resolution (bin size of the FFT), specified also in terms of the QRSS speed, the original reason why Argo was initially developed.

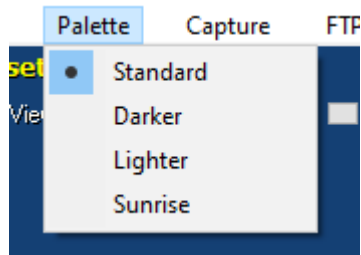
The number after the characters QRSS indicates the duration in seconds of the CW dot. So, QRSS30 indicates that the resolution and speed of Argo is optimized to receive a slow CW signal with a dot duration of 30 seconds... needed for signals far below the noise.

The scrolling speed can be further adjusted with the use of the Speed menu,

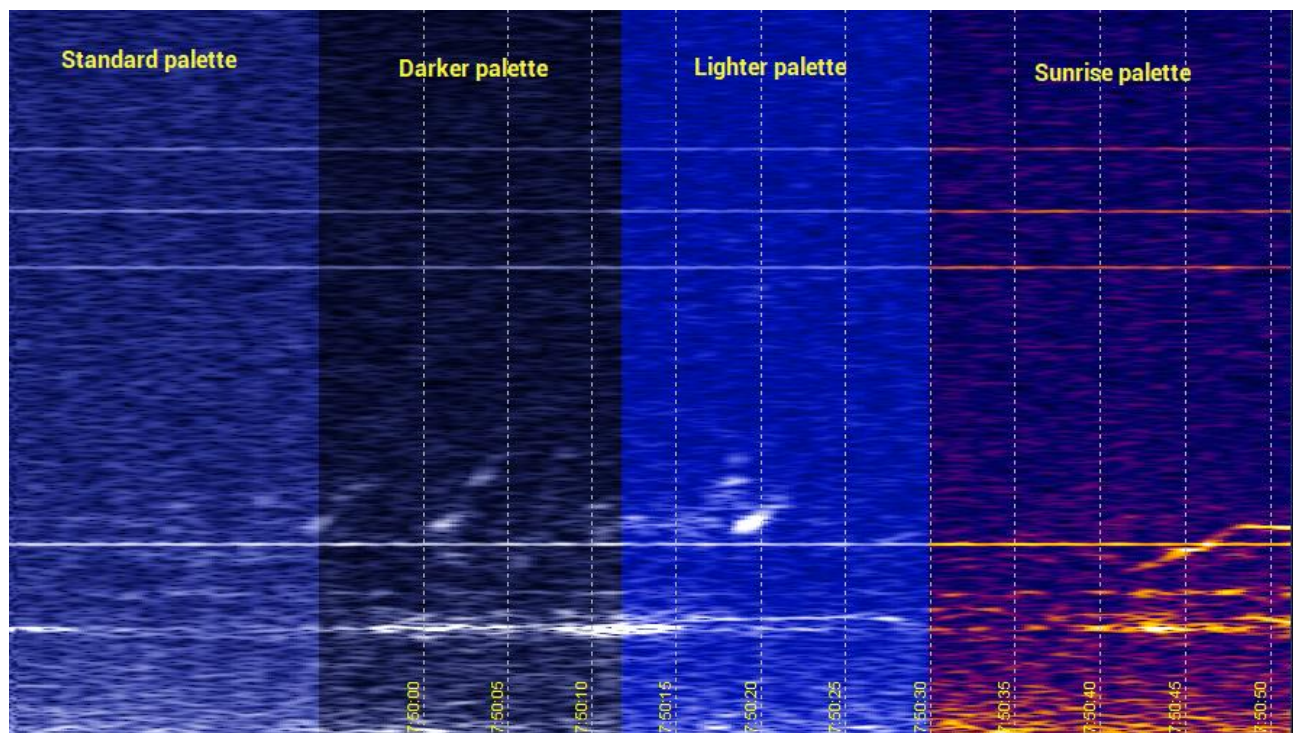


In the Mode menu you can specify whether to apply an averaging factor (ranging from 1 to 4096) to the Spectrum only, or to both Spectrum and Waterfall. The other choices of this menu are more or less self-explanatory.

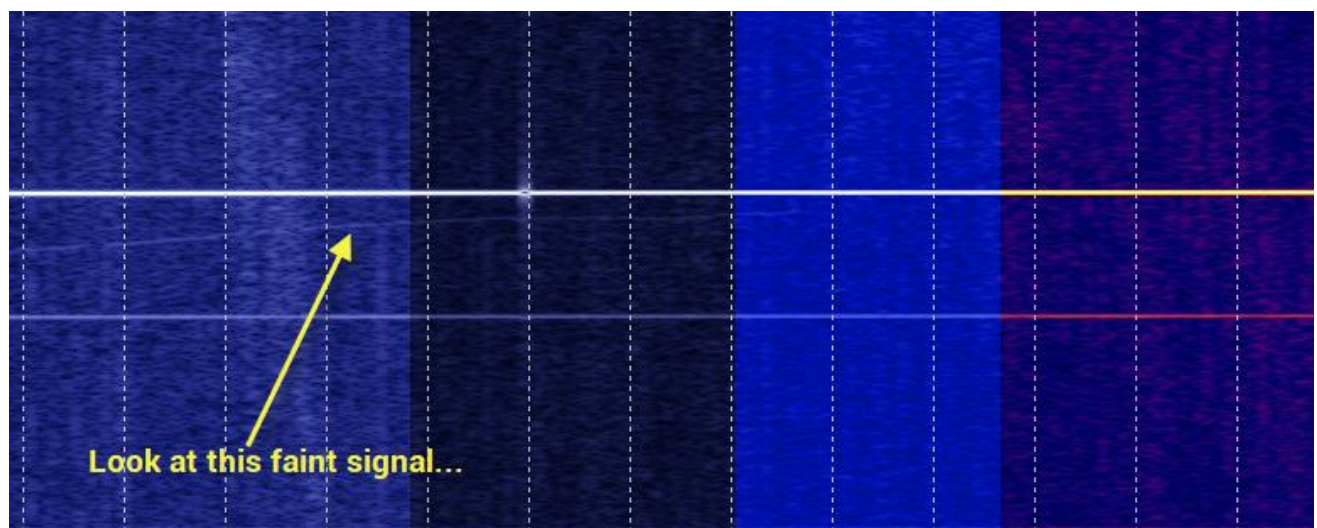
The Palette menu



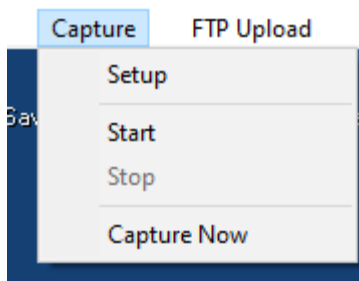
This menu allows to select which color palette to use for the waterfall. The choice is dependent on the taste of the user, though there are some subtle differences in the ability of the program to highlight weak traces in the background noise. An example :



Another example :

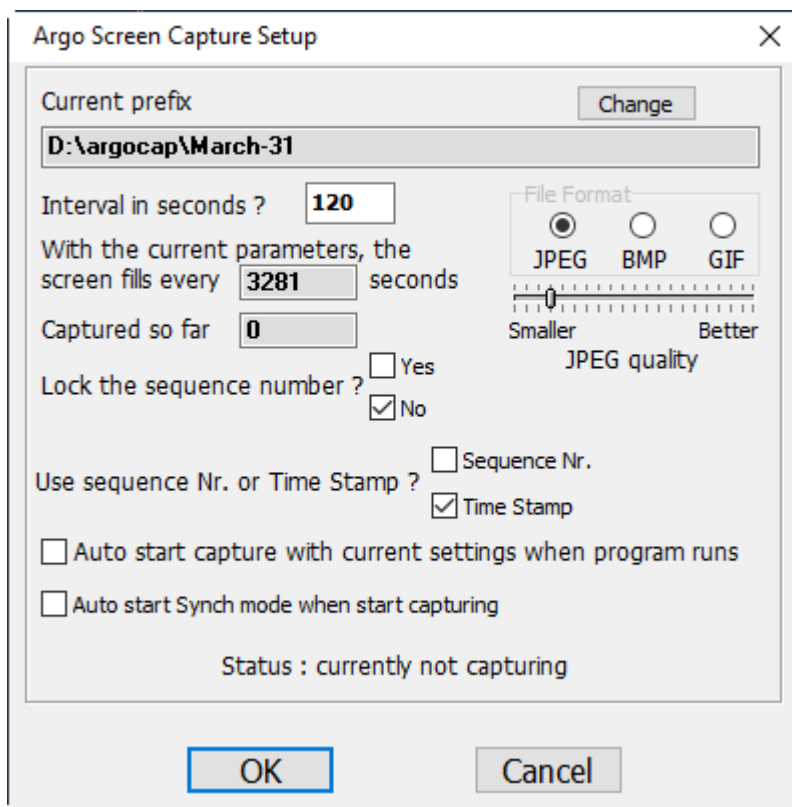


The Capture menu



Before doing any screen capture, you must fill the Setup choices, unless set in a previous session, which the program will remember.

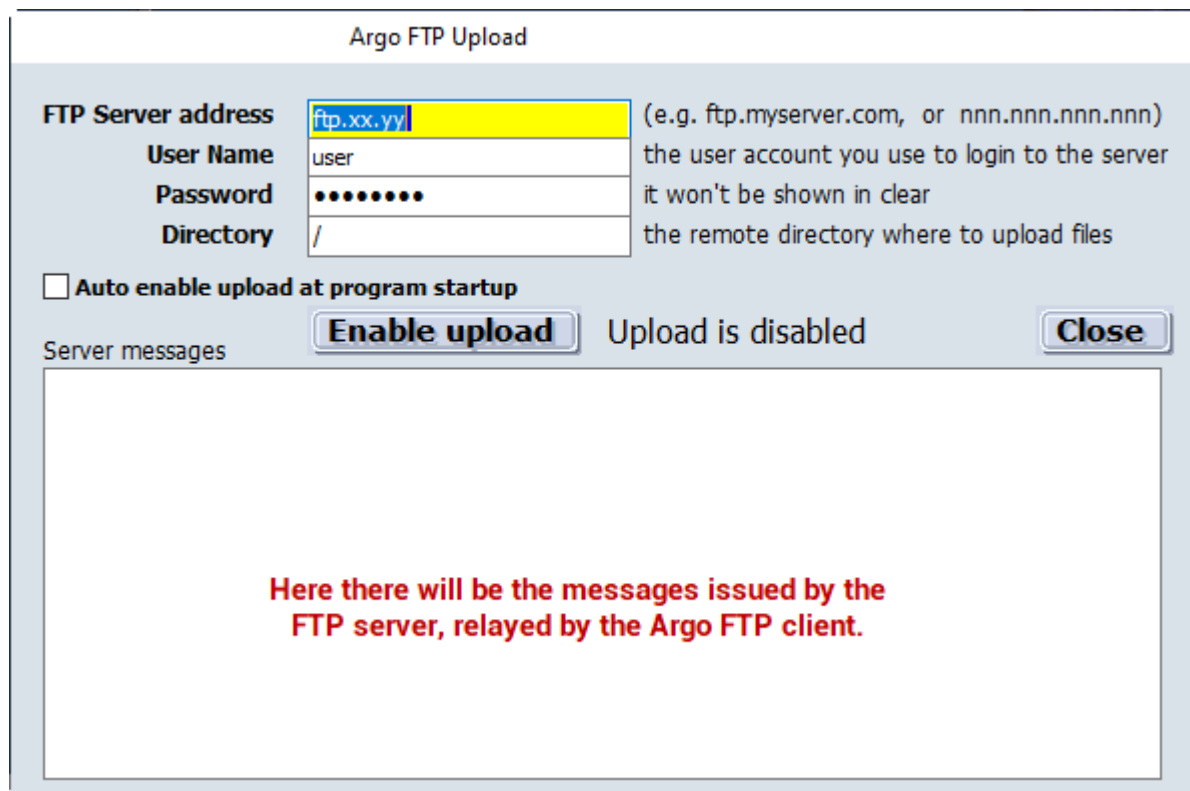
The Setup sub menu



Here the choices are more or less self-explanatory. My suggestion is to set the format to JPEG, and the quality to a low value, as shown in the figure. The resulting capture will have a very acceptable level of quality and reduced file size, useful for posting in groups where there is limit for the message size.

The FTP Upload menu

Argo can upload the screen captures to an FTP server, e.g. ftp.qsl.net or to a personal Web site implementing a timed grabber.

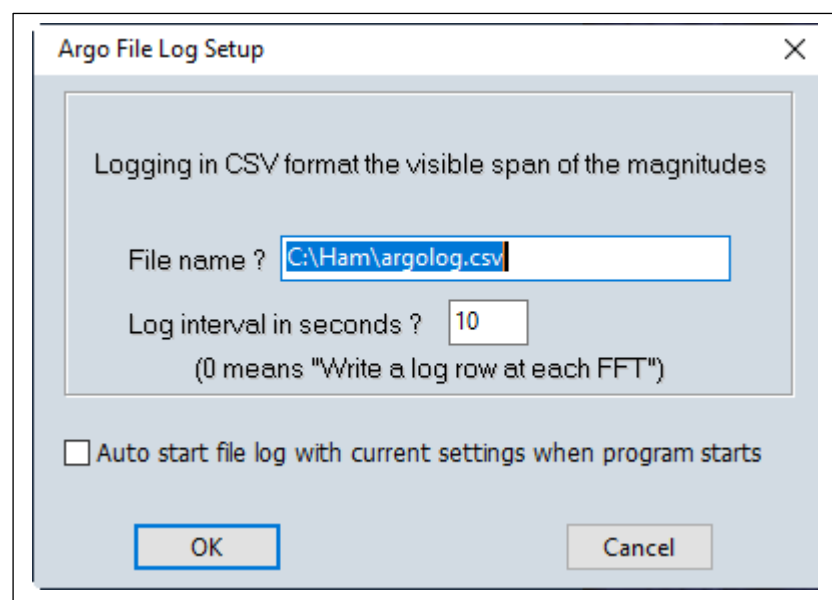
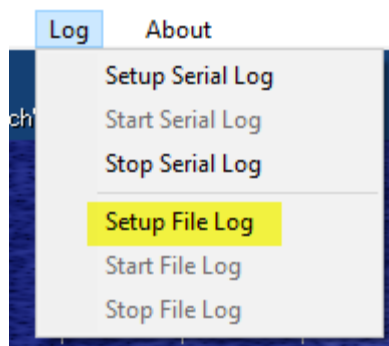


The 'Argo FTP Upload' dialog box contains the following fields and controls:

- FTP Server address:** A text field with 'ftp.xx.yy' entered. To its right is the text '(e.g. ftp.myserver.com, or nnn.nnn.nnn.nnn)'.
- User Name:** A text field with 'user' entered. To its right is the text 'the user account you use to login to the server'.
- Password:** A text field with nine dots. To its right is the text 'it won't be shown in clear'.
- Directory:** A text field with '/' entered. To its right is the text 'the remote directory where to upload files'.
- ☐ **Auto enable upload at program startup**
- Server messages:** A label above a large text area.
- Enable upload:** A button.
- Upload is disabled:** Text next to the 'Enable upload' button.
- Close:** A button.
- Message text (in red):** 'Here there will be the messages issued by the FTP server, relayed by the Argo FTP client.'

The Log menu

The FFT magnitudes computed by Argo, and used to draw the waterfall and the spectrum can be saved to a .CSV file if a post-processing is desired, either via a spreadsheet program, or a user-written code.



The 'Argo File Log Setup' dialog box contains the following fields and controls:

- Title:** 'Argo File Log Setup' with a close button (X) in the top right corner.
- Description:** 'Logging in CSV format the visible span of the magnitudes'.
- File name ?** A text field with 'C:\Ham\argolog.csv' entered.
- Log interval in seconds ?** A text field with '10' entered. Below it is the text '(0 means "Write a log row at each FFT")'.
- ☐ **Auto start file log with current settings when program starts**
- OK:** A button.
- Cancel:** A button.

The format is as follows :

- time stamp, of the form "DD/MM/YY, HH:MM:SS" (the exact format depends on the locale settings)
- starting frequency (float format)
- frequency increment between consecutive values (float format)
- number of values (integer format)
- N values, where N is given by the field before (float format)

All the fields are separated by a comma. As an example, here following is the beginning of an actually logged row :

31/03/2025 ,18:25:33,591.061,0.022888,767, -114.869,-132.694,-114.998,-116.201,etc. etc.

Don't forget to press the "Start File Log" to start the file log, after having set the parameters.

Now some general usage explanations

It is hoped that the usage of Argo is easy and intuitive and any questions the user may have regarding its use or settings are encouraged to be asked. The Start button starts the spectrogram (waterfall). The Spectrum button toggles ON/OFF the visibility of the Spectrum window, where the spectrum corresponding to the current waterfall is shown.

The Mode menu choice allows to set the viewing mode as described previously and to select or deselect the full band viewing, and also the length of the time ticks (short or full stroke),

If you left-click on the spectrogram, the behavior depends on the mode you are in.

If in Full Band View, the display will change from a vertical flow to a horizontal one, centered at the chosen frequency, keeping the last resolution used.

If you are already in the horizontal display mode, the chosen frequency will be simply brought at the center of the range.

If you do a right-click, the mode toggles between full band view and the currently selected QRSS mode, without changing the center frequency.

When you just hover the mouse on the spectrogram, the relative signal strength in that point will be indicated.

The 0 dB reference level can be selected between the magnitude of a monochromatic signal that would just saturate the ADC of the sound card, or the magnitude of a signal arbitrarily selected with the mouse. The relative magnitude displayed near the peak frequency is however always referred to the ADC full scale.

In the vertical display mode, if you left-click on the upper frequency scale, keeping the mouse button down, you can drag left or right the scale to see the desired portion. Similarly, in the horizontal display mode you can drag up and down the far-right frequency scale, to show the desired segment.

When exiting from the program all the current settings will be saved into an .INI file and restored at next start.

Additionally, you can save the current settings under a given name, and reload them in a subsequent session. Thus, you can have multiple settings, for each favorite display mode.

A small square just on top of the level bar indicates with its color (green or red) whether the CPU is overloaded. No harm is caused by overloading, just the screen refresh speed becomes slower and some information is lost.

The Visual Gain panel has three choices, AGC, Low and High. They refer to the type of processing done when mapping between signal magnitudes and saturation of the waterfall.

The waterfall works in the HSV color space, where H has been arbitrarily chosen by me as a pleasant (!) shade of blue, V is always 1 and S is the output of the non-linear mapping algorithm. The Sunrise palette is just a little different, but I won't enter into technical details here.

The AGC (Automatic Gain Control) choice does not refer to the AGC function that some sound cards have. Instead, it makes the mapping above mentioned between the magnitude values and the color saturation on the waterfall, such that it depends only on the ratio between the instantaneous value and the low quartile boundary increased by 3 dB, which is a good representation of the current noise level (thanks to Andrew Talbot G4JNT, for this idea).

With AGC off, the absolute value of the current spectrum sample is used instead, with a fixed gain selected between Low and High.

The net effect of having AGC on is to make the waterfall largely independent of the input audio level (of course within limits...). Try for yourself, play with the Sensitivity and Contrast sliders, it takes some fine adjustments to obtain the best results.

With the Low and the High settings, the dB scale on the Spectrum window will stay put, albeit non linearly depicted on the panel. When AGC is selected, that dB scale will move slightly up and down... this is an effect of the AGC itself...the algorithm tries to preserve the brightness of the waterfall, minimizing the effects of the signal amplitude variation. But at the same time the dB magnitudes must be correctly shown, and this causes that rearranging of the scale.

The screen grab function

The program has a built-in facility for capturing its waterfall window to a disk file, at timed intervals.

To activate it, choose Capture | Setup from the main menu, to specify the radix of the capture files.

The program will use this radix, adding a 4-digit progressive suffix, or, optionally, the current time stamp. Then you will be asked for the number of seconds of interval between each capture.




With a very fast PC you can even say 1 second, but better not...

The program will automatically compute the time interval to specify to have a capture every full screen of data (actually a bit less, so to give a bit of overlap).

This is done using the current settings. If you change the speed or the mode, you have to readjust it.

Then choose the format, JPEG, GIF or BMP. A BMP image will take far more than 1 MByte, a GIF file will be on the order of 100 kB, while a JPEG image usually is less than 100 kB (with the suggested JPEG quality), so use JPEG unless you know in advance that you will not be able to process the other formats. Of course, the file size will depend on the contents of the screen.

This is an example of a capture done just now :

 test0001.bmp	01/04/2025 19:37	BMP File	3,154 KB
 test0001.gif	01/04/2025 19:36	GIF File	98 KB
 test0001.jpg	01/04/2025 19:37	JPG File	55 KB

The Start and Stop choices in the Capture menu speak for themselves.

The Start choice is enabled only after having specified the capture parameters.

The Capture Now choice takes a single snapshot of the screen when pressed.

The screen is always correctly grabbed, even if the Argo window is totally or partially covered by other windows, or minimized.

The WAV file read/write function

Argo can save the incoming audio to a standard WAV file, which then can be used as input, instead of the sound card.

The sampling rate set into the audio device is dependent (as previously described) by the Freq.Range set. But the sampling rate will be always converted to 6000 Sample/sec when writing the wave data to the WAV file.

Wave recording can be Paused, Resumed or Stopped using a couple of buttons that will appear when recording has been activated.

To read from a WAV file instead of the sound card, click on the action bar on Setup | Select Input | Open Wave File...and then specify the filename. Must be a single channel, 6000 Hz wav file, as saved by the wave save function of Argo, or by another program.

When WAV file playback is running, WAV write is still enabled, so you can transfer a portion of a WAV file to another new file.

During WAV playback a couple of radiobuttons is visible on the top of the screen, that will allow to choose between Normal Throttle, Full Throttle and Replay. In Normal Throttle mode, the spectrogram will have a timing similar to real time capture. In Full Throttle mode, the spectrogram will flow at the maximum speed that the hardware of your PC will allow.

For this reason, in Full Throttle mode the timing ticks are disabled.

The Replay choice speaks for itself.

Saving audio and screen synchronized

On the upper part of the main panel the user will find these two buttons :



The left one will start a WAV file capture, as described above. The right one responds to a need of a group of users, who desired to have not a single WAV file, but many files, each one corresponding to a single screen grab. Frankly, I do not remember now what this function was requested for, but it is there, in case you need it.

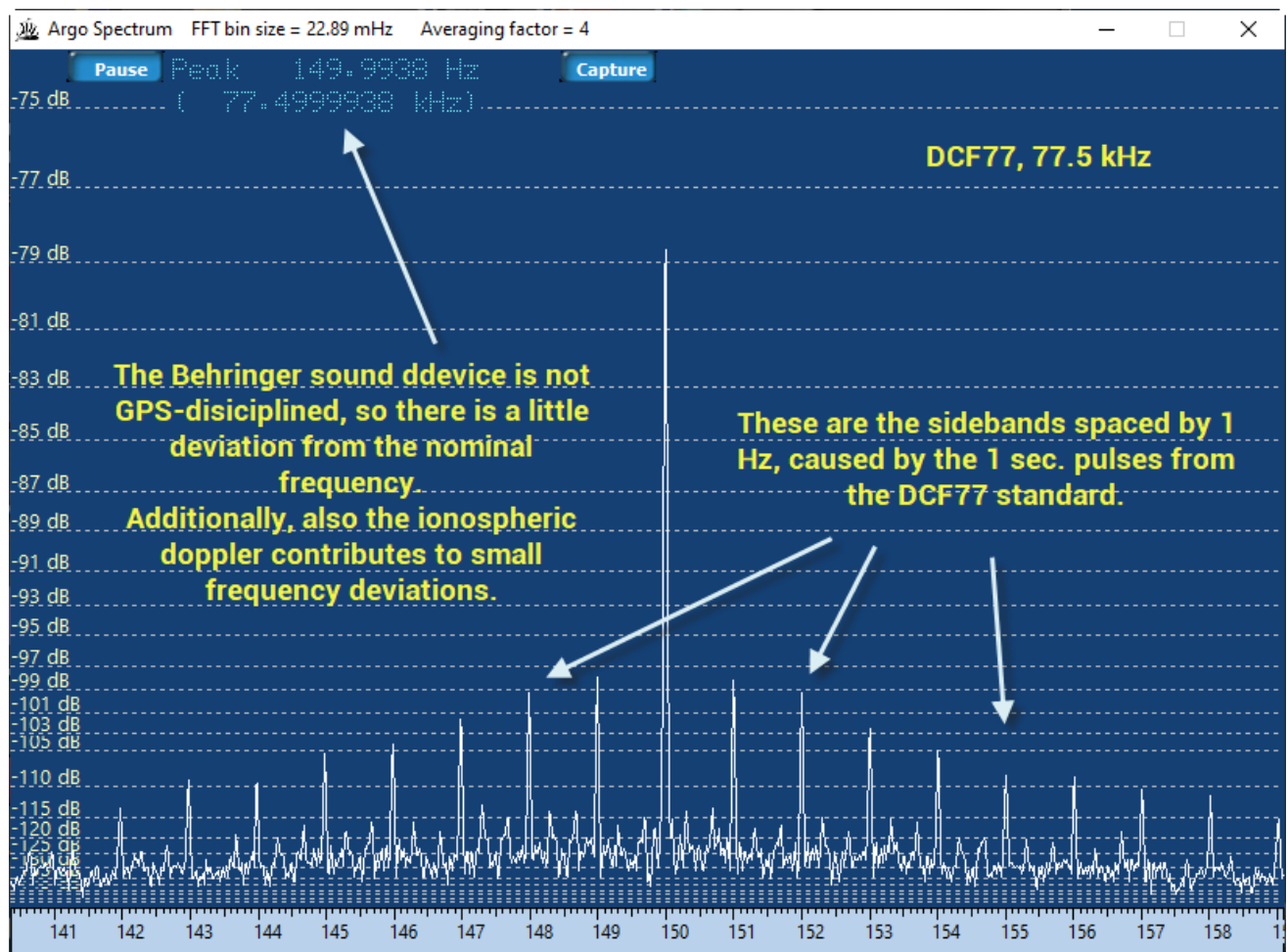
The spectrum

This just an example of how the spectrum shows.

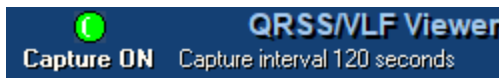
Here it is possible to see the spectrum of the time and frequency standard DCF77, from Mainflingen, Germany, transmitting at 77.5 kHz.

The reception was done with a mini-whip antenna connected to a Behringer UMC202HD USB device, sampling at 192 kS/s. Argo did a downconversion to 150 Hz, and the spectrum scale is centered to this value. The original frequency value is also reported.

The shown frequency is not exactly 150 Hz, as the sampling frequency of the Behringer device was not GPS-locked. This feature will be implemented in the next version (2.1) of the program



A last note : at the bottom of the screen, you will find this LED indicator



It indicates whether the screen grab function is active. You can even start and stop that function by clicking on that LED...

Things to be still implemented, in a future release

- Using a GPS receiver to correct frequency errors and sampling stability of the audio device.
- Possible extension of the maximum resolution to 22.35 μHz .
- Transmission via the UDP protocol of the magnitude values, instead of using the serial port.
- Other nonsense that will come to mind....

Thanks for reading up to this point, and enjoy Argo.

73 Alberto I2PHD

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