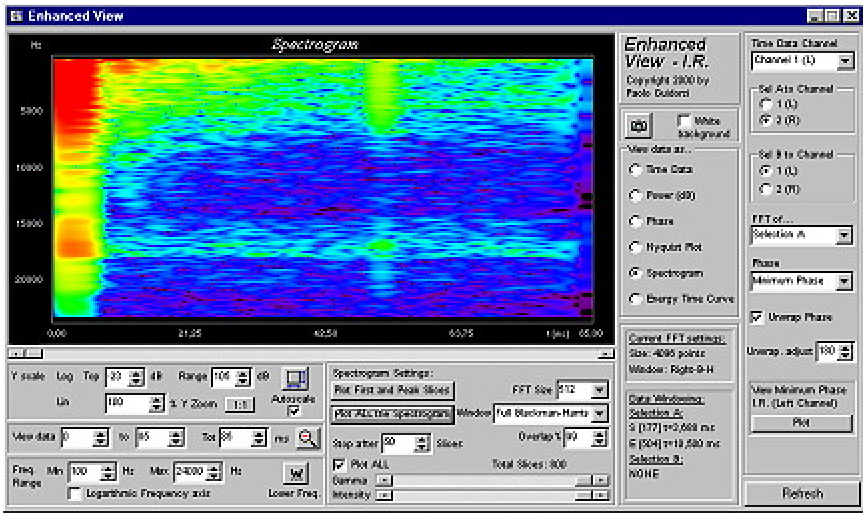
Sample Champion - Application note # 15

Enhanced View Plugin: ETC, Spectrogram, Nyquist Plot...

This application note describes the use of the Sample Champion Enhanced View Plugin. This module gets the current Impulse Response (1 or 2 channels).



Enhanced View Plugin. Spectrogram of Example1.ire file

An Impulse Response must be loaded or measured and one of two data selections (A and/or B) must be enabled in Sample Champion. Now the Enhanced View Plugin can be opened.

The frequency analysis performed by this module is driven by the data windowing (Selections A and B) and FFT settings (FFT size and window type) of the main program. Selections A and B can be assigned to channel 1 or 2 of the Impulse Response (if stereo) from the plugin. Moreover the frequency data of the 2 selections can be plotted simultaneously selecting "FFT of Selection A and B".

The button marked "W" inside the "Frequency Range" box sets automatically the lower frequency of the plot according with the resolution due to the data windowing length.

Remember that the lower resolution limit depends (for every measurement method) on the weighting window length and type. The rectangular window has a frequency resolution of 1/T Hz, the Blackman-Harris about twice.

The computed phase can be plotted in 3 different ways:

- Measured phase (wrapped or unwrapped)
- Minimum phase (always unwrapped)
- Excess phase (always unwrapped)

Note that the minimum and excess phase algorithm requires intensive computations, so data selections in the main program must be moved or changed with care when one of these view modes is selected.

Minimum Phase Impulse Response of data inside Selection A can be computed and plotted by pressing the button "View Minimum Phase I.R.". This works only for mono impulse responses or for channel 1 of stereo impulse responses. The minimum phase recostruction (used also for minimum and excess phase computation of Selections A and B) is obtained by means of cepstral analysis.

If **h** is a vector containing the windowed impulse response then:

Cepstrum = IFT(log(abs(FFT(**h**))))

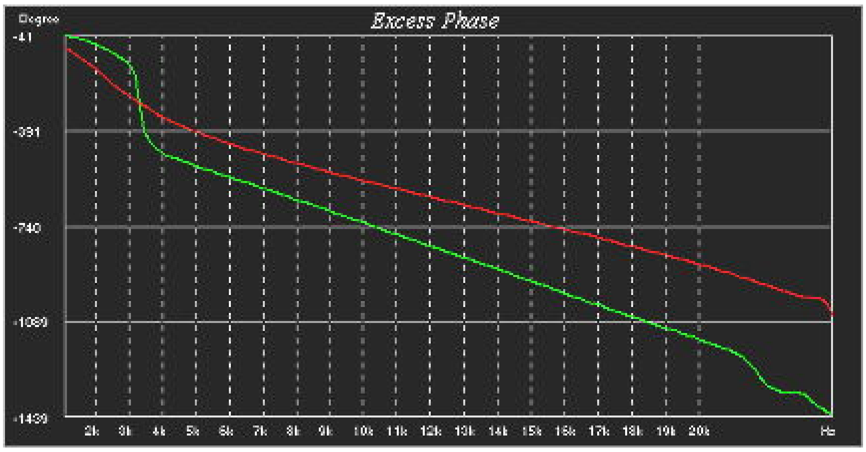
Only the causal part is retained from the **Cepstrum** vector, by zeroing its second half (obtaining **Cepstrum2**). The minimum phase Impulse Response is obtained by means of the following operation:

MinPh = IFT(exp(FFT(**Cepstrum2**)))

To obtain the minimum phase spectral data, the **MinPh** impulse response is computed and analyzed with current FFT settings. Data windowing in this case starts from t=0 (because homomorphic reconstruction moves the beginning of the obtained impulse to t=0) and has the same length of the current Data Selection (A or B).

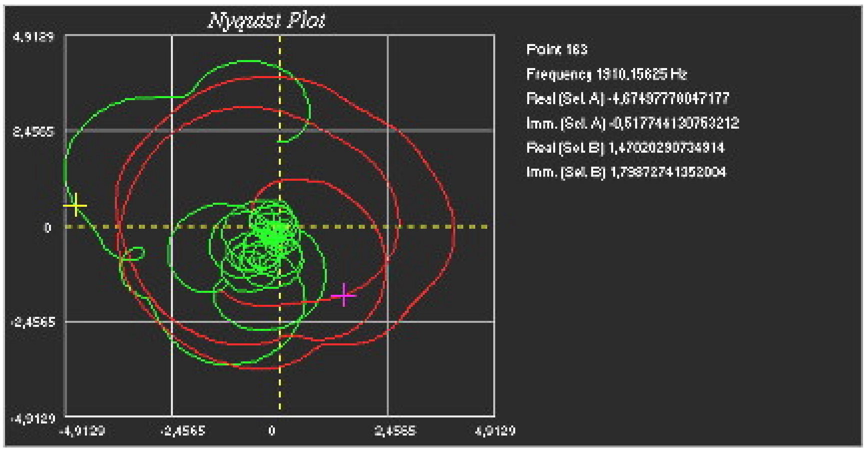
Excess phase is simply the difference between (unwrapped) measured phase and minimum phase.

Example of minimum phase spectral data of Selections
A and B (green=channel 1, red=channel 2)



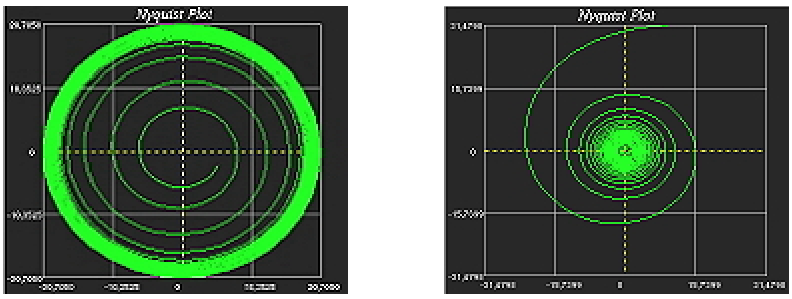
Example of excess phase spectral data of Selections A and B

Frequency data can be viewed also in the form of Nyquist plot. This view mode plots Real and Imaginary data respectively on X and Y axes. By mouse-dragging the bar under the graphic plot, the data values can be visualized.



Example of Nyquist plot (Selections A and B)

The 2 following figures show an example of Nyquist Plot of a loop-back impulse response before and after Pink Filtering.



Example of Nyquist plot of a loop-back measurement before and after Pink Filtering

The Spectrogram function computes and plots the distribution of the frequency content of the Impulse Response along the time axis. Time is reported on the X axis, frequency on Y axis, color denotes dB power spectrum levels (red=higher, blu=lower). Every slice (vertical line) is obtained by computing the FFT of the data windowed around the considered time position. The spectrogram FFT length and window type are independent from the main program settings and can be set by the user. The "Overlap" percentage indicates the overlapping factor between adjacent data windowings.

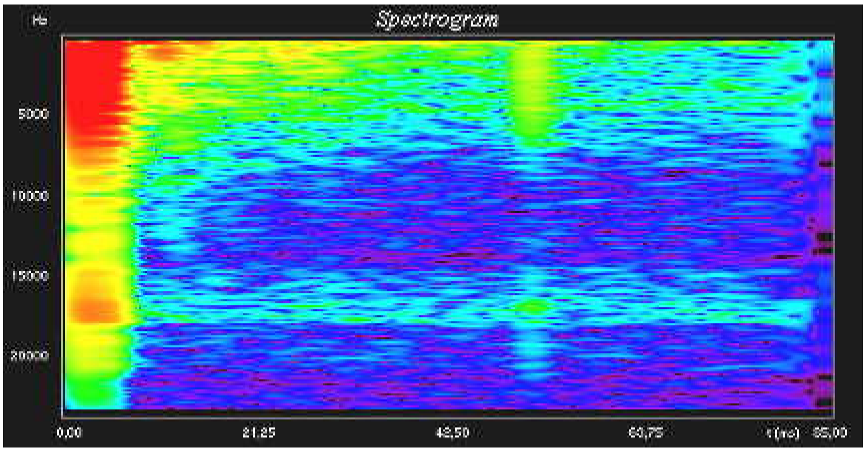
A proper setting of spectrogram options requires some training and testing. Every Impulse Response has different characteristics and requires specific values of FFT length, Window and Overlap percentage.

Some tests can be performed by pressing the "Plot First and Peak Slices" button: the slice centered at t=0 and the slice centered at the time location of the Impulse Response peak will be plotted. Then the Top and Range of the graph and the frequency lower and upper limits can be set. It is suggested to set linear frequency view mode.

As first choice, the "Plot WHOLE Spectrogram" button can be pressed (with "Plot ALL" option unchecked). This will plot only the first slices (the number can be set).

When you are satisfied with the result, the "Plot ALL" option can be checked and finally, pressing the "Plot WHOLE Spectrogram" button, the whole spectrogram will be plotted.

CAUTION: depending on the settings, the spectrogram could require much time to be plotted, because several hundred or thousands of FFTs must be computed. So the "Plot ALL" option must be checked only when you are sure that every parameter is right.



The spectrogram shown above is obtained from Example1.ire file (a Loudspeaker Impulse Response) with the following settings:

- Top Graph=-23 dB

- Range Graph=105 dB

- Spectrogram FFT size=512 points

- Overlap=99%

A first reflection is clearly visible in the proximity of t=50 ms.

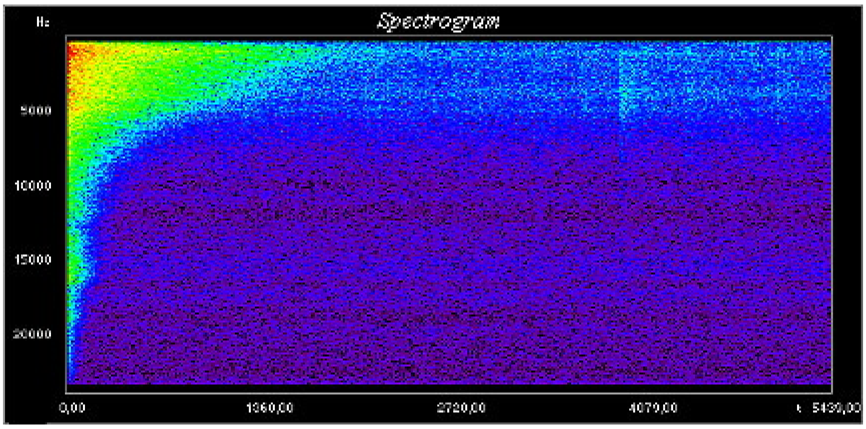
The 2 figures below plot a 256K room Impulse Response measured in a large hall. The settings for computing this spectrogram are the following:

- Top Graph=-16 dB

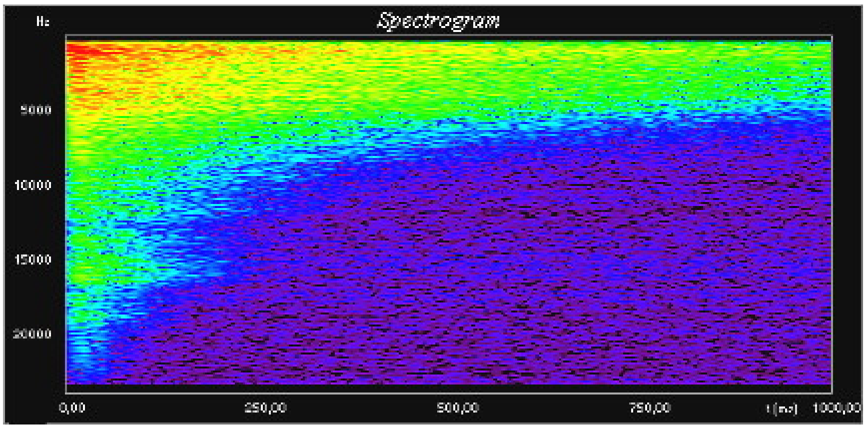
- Range Graph=115 dB

- Spectrogram FFT size=2048 points

- Overlap=87%

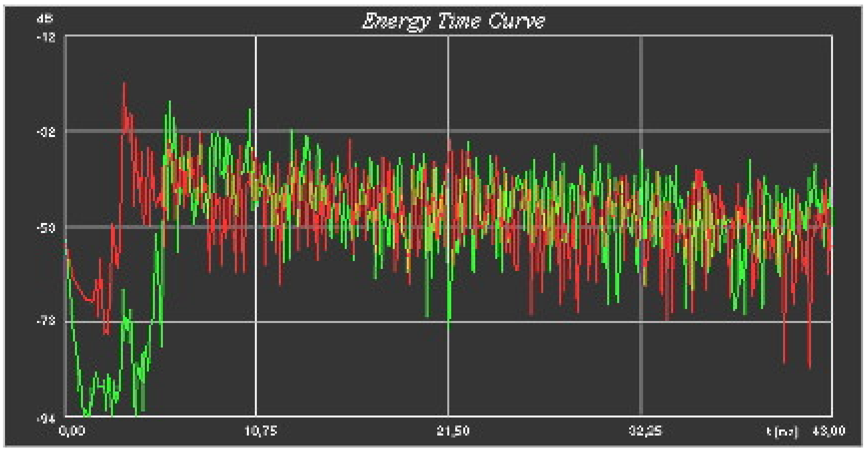


Spectrogram of a large hall impulse response



Zoom of the above Spectrogram (first 1000 ms)

Also the Energy Time Curve of time data can be plotted. ETC is similar to the Log Squared view mode available in the Room Acoustics plugin, but is computed by means of the Hilbert Transform of the Impulse Response.



Example of ETC curve (2 channels)