



*SPECTRA*foTM

VISUAL AUDIO MONITORING SYSTEM

Operations Guide



Congratulations!

You are now the owner of the most powerful audio analysis and metering system on the planet.

SpectraFoo is capable of monitoring up to 24 separate channels simultaneously (depending on the speed of your Mac and your input hardware). You may be asking 24 channels all at once? How is this possible? The answer is that SpectraFoo uses Metric Halo Lab's patent-pending high-resolution analysis engine. This technology uses the power of your Macintosh RISC Processor in conjunction with your audio hardware to provide blazingly fast and incredibly detailed sample-accurate Analysis and Metering of any channel or an entire mix. SpectraFoo technology is unique in its ability to provide you, the engineer, spectral, power, and phase analysis which is truly useful to your production tasks.

About This Guide

This guide is divided into three sections 1. The SpectraFoo analysis engine - This is an introduction to the underlying technology behind SpectraFoo and how it differs from other Audio Analysis techniques. 2. SpectraFoo instruments - This is an overview of the 12 types of track assignable Analysis instruments available in SpectraFoo. 3. Using SpectraFoo - This section explains how you interact with SpectraFoo. SpectraFoo utilizes Metric Halo's innovative multi-window multi-channel audio routing technology to allow you to create multiple resizable instrument windows that always remain active

Introduction – The SpectraFoo Analysis Engine

Welcome to the SpectraFoo Visual Audio Monitoring System – the world's first audio analysis environment that actually lets you see music. SpectraFoo is a high-precision, low-latency, fully realtime audio visualization and analysis system.

SpectraFoo takes advantage of the phenomenon known as synesthesia. The word synesthesia, meaning “joined sensation,” denotes the rare capacity to see sounds, taste shapes, or experience other equally startling sensory blendings whose quality seems difficult for most of us to imagine. Very few people experience natural synesthesia. Those who do usually possess distinct cognitive advantages over the rest of us. For example, many people with perfect pitch associate particular pitches with particular colors. They see sound as well as hear it. The interaction of vision and hearing helps these people maintain an absolute point of reference with regard to pitch. This allows them to discern absolute pitch values without the need for a reference tone. SpectraFoo allows anyone to experience the benefits of synesthetic sensation.

In order for the human brain to properly integrate multiple sensory inputs and derive greater value from them, the inputs must be truly synchronized. SpectraFoo is the first audio visualization system to provide high resolution spectral and phase information that is fluidly animated and absolutely synchronized to the live audio signal. It is the first audio analyzer anywhere to allow the user to tap into the power of synesthesia.

Like many other audio analyzers, SpectraFoo's analysis engine is based on the Fast Fourier Transform (FFT). The FFT algorithm is an efficient means of computing a Fourier Transform on a computer. The Fourier transform was developed between 1804–1807 by the mathematician Joseph Fourier as part of a study of heat transfer. The Fourier transform converts a continuous record of amplitude vs. time into a record of amplitude vs. frequency. A modification of the Fourier Transform called the Discrete Fourier Transform (DFT) was developed to deal with sampled rather than continuous waveforms. The FFT algorithm was developed as an efficient way of computing the DFT on digital computers.

FFT-based analysis facilitates highly precise measurements. As a result, it has become a natural choice for audio analysis systems. Unfortunately, FFT-based methods have historically been more suited to Electrical Engineering-type audio measurements than dynamic measurements of musical program material.

A traditional technique is to subject the system being measured to a known, controlled test signal. In order to get high-resolution measurements from the analyzer, one must wait for a significant period of time while the output of the system is captured by the analyzer and then transformed. If you want to measure the average response of the sys-

tem, you have to wait for the analyzer to make many captures, transform them and average them before you see the results.

With traditional transformation algorithms, the rate at which the signal is transformed is constrained by the spacing of the spectral lines. As a result, many professionals who work in the creative side of audio have resorted to using low-resolution RTA-type analyzers to get real-time information. SpectraFoo utilizes patent pending technology to decouple the transformation resolution from the transformation rate. As a result, SpectraFoo is *fast, fast, fast!* It can perform multichannel FFTs up to 84 times a second, allowing you to see spectral features as small as 5 Hz wide while staying absolutely synchronized with the source material. This allows you to experience and analyze sonic events simultaneously!

In addition to its unmatched realtime performance, SpectraFoo also provides a full suite of highly precise quantitative analysis tools, including a capture and storage system which is seamlessly integrated into the monitoring environment. All of the intuitive knowledge you have gained via synesthesia can be leveraged on top of the quantitative measurements that SpectraFoo provides.

The following is a quick start guide that provides an overview of SpectraFoo's features and capabilities. This guide assumes that you have a basic working knowledge of the MacOS and its standard techniques. If you are new to the MacOS, you should consult your Apple documentation before continuing.

System Requirements

1. A PowerPC-based Macintosh compatible computer. SpectraFoo *will not* run on 68k based machines. PCI-based computer is recommended. G3-based (or 9600/8600 @ 300 Mhz or more) machines are the ultimate platform for SpectraFoo.
2. 2nd Level Cache is highly recommended – the more, the better. SpectraFoo will run without 2nd level cache but performance will suffer dramatically.
3. SpectraFoo will run with about 6 MB of available memory comfortably. This means that with current systems, 16 MB is the minimum requirement for RAM. However, if you plan to do extensive captures, RAM requirements increase dramatically. Stereo audio requires about 150 kB/sec plus some extra overhead for SpectraFoo to format the capture.
4. The Delay Finder requires at least 2.5 MB of additional RAM to function properly. The Delay Finder is a utility that allows you to identify and compensate for propagation delays when doing transfer function based testing.
5. SpectraFoo supports MacOS Systems: 7.5.3 – 8.1. Other versions of the system software may be usable but have not yet been certified.
6. SpectraFoo works best on a color monitor with a color depth of 256 colors. SpectraFoo will work with any monitor resolution, but 1024x768 or greater is recommended. If you are not sure about how to adjust your monitor, consult your Macintosh documentation.
7. SpectraFoo is compatible with networking, file-sharing, most third-party extensions, and almost everything that you would like to have on your computer. We make very few demands. Unfortunately, RAMDoubler and virtual memory are not currently supported.
8. If you want to do analysis referenced to external timecode, you need to have OMS (Open Music System) installed. OMS is available from Opcode Music Systems and can be freely downloaded from their website (<http://www.opcode.com>). Unfortunately, FreeMIDI does not appear to support the Opcode Timing System, so you cannot use FreeMIDI in OMS compatibility mode to acquire timecode with SpectraFoo. You will also need hardware capable of generating MIDI Time Code (MTC).

Quick Installation Guide

Installing your Metric Halo software product is a simple 7 step process.

1. Insert the installation media (CD or diskette) into your computer.
2. Double-click the “Installer” application.



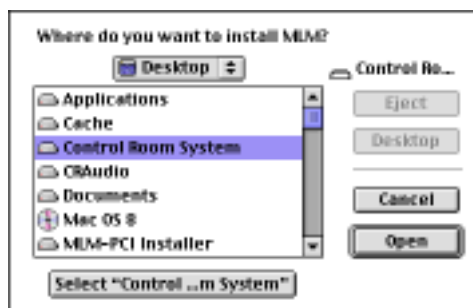
Installer

3. After a few seconds an installer dialog will appear:



Enter the serial number that is printed above on the License Certificate and then enter your phone number, name and (optionally) company.

4. Click the “Select Destination Directory...” button to choose the software installation location. A folder selection dialog will appear:



Navigate until you have selected the folder in which you want to install the software and then click the “Select...” button at the bottom of the dialog. The folder selection dialog will close

5. Now click the “Install” button in the Installer dialog. Installation will require about 1 minute.
6. Congratulations! Your software is now installed. The installer has provided a temporary license so that you can get started immediately. You will have to register the software with Metric Halo within 12 days to get the authorization code to convert the license to a permanent one.

Each time you start the software (until you have authorized it) the following authorization dialog will appear:



You can use your software immediately (even before it is authorized) by clicking on the “Not Yet” button.

In order to authorize your software you will have to obtain an authorization code from Metric Halo.

There are two methods by which you can obtain an authorization code from Metric Halo:

- (1) [Preferred] Click the “Copy for Email” button in the authorization dialog. Click the “Quit” button. Start up your email application and paste the contents of the clipboard into a message addressed to “in-foo@mhlabs.com”. We will send you the authorization code via email. We prefer this method because it eliminates the possibility of “garbled transmission” over the phone.
- (2) Call (914) 462-1230 and register over the phone.

7. After you have received your authorization code, type it into the “Authorization Code” box in the authorization dialog. If the code is correct, the “Authorize” button will become enabled. If the button does not enable, check your typing. Click on the “Authorize” button to convert your license to a permanent one.





After you have converted your license, the authorization box will no longer appear.

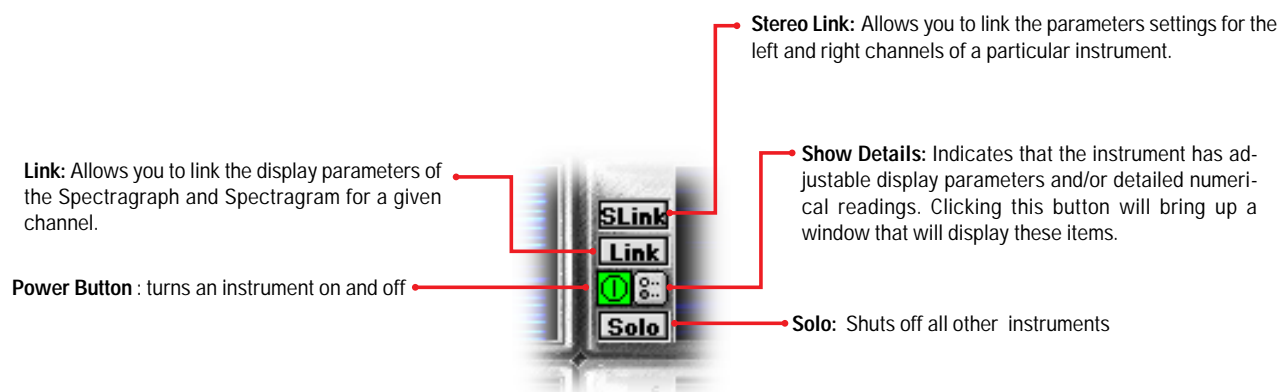
SpectraFoo Instrument Summary

Introduction

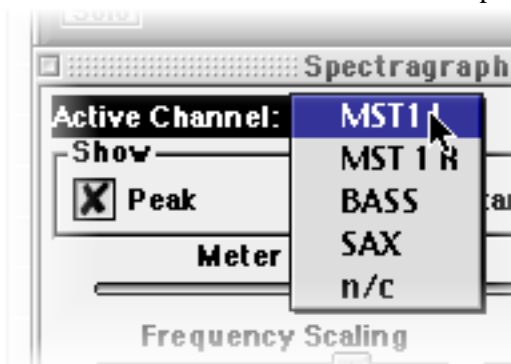
SpectraFoo provides you with a wide variety of audio monitoring and analysis instruments. You may access any combination of the instruments at any time. This allows you to use as much or as little analysis as you want. The following section describes the instruments available to you and how they work. Please refer to the Section on Control and Routing to learn how to control the flow of signal through SpectraFoo.

Common Features

All of the instruments have a power button , a solo button  and a parameter control button . The power button, when turned off, disables the instrument. The solo button works much like the solo button on a recording console in that it shuts off all of the other instruments. However, if more than one instrument is in solo mode, all of the soloed instruments will continue to run, while the un-soloed instruments will be disabled. If an instrument is in solo mode and turned off, it will be disabled, as will all of the un-soloed instruments. These controls are provided to allow you to focus your attention on measurements made by a subset of SpectraFoo's instruments. When the parameter control button  is clicked, it opens a control window which allows you to control, in real-time, many of the display parameters for the instrument in question. These control windows will be described in more detail below.



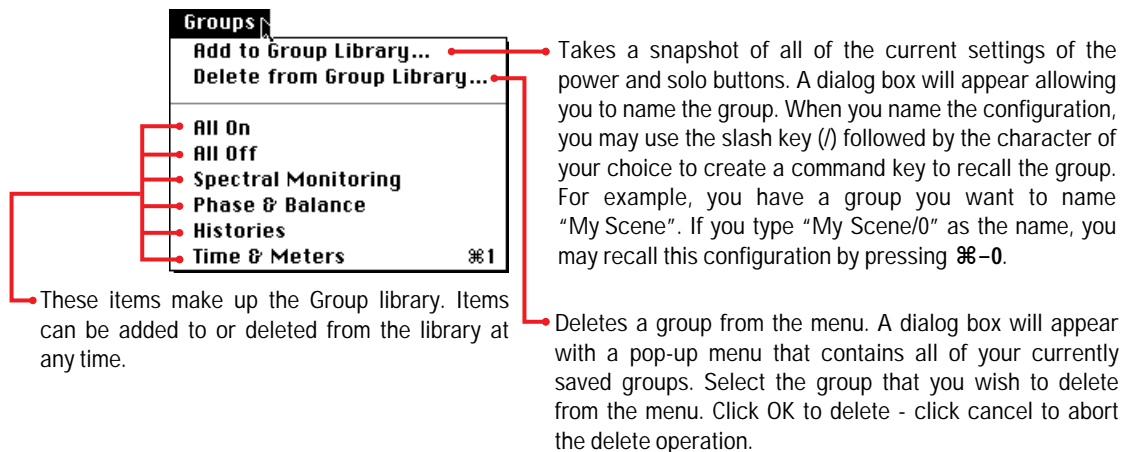
One common feature in the control windows for all the instruments is the **Active Channel** pop-up menu. This allows you to select the which analyzer channel is routed into the instrument for display.



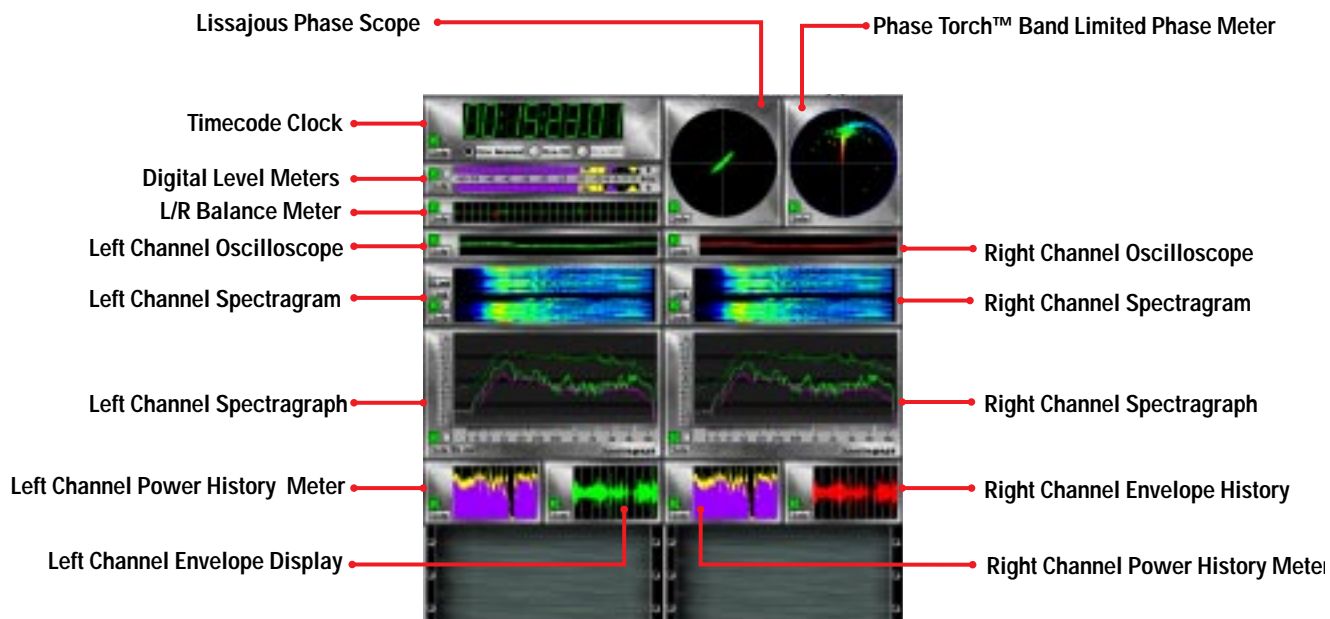
Although SpectraFoo is always analyzing the signal in real-time, limitations in the drawing speed of the host computer can cause the display to slow down when all of the instruments are enabled. By soloing the instruments that you are specifically interested in at a given point in time, you will improve real-time performance of the display. For faster host machines, the difference in graphics performance will be less noticeable. In general, on most machines,

you can run 4 or 5 instruments with no noticeable degradation in the graphics performance, and the graphics performance is usually still acceptable even with all of the instruments enabled.

You can set up predefined groups of enabled instruments using the commands found in the group menu. This allows you to quickly and easily “switch modes” as far as where your attention is focussed. Currently, instrument groups only effect instruments in the consolidated Real Time Rack view described below.



SpectraFoo provides a two-channel consolidated “Real Time Rack” view that contains the all of the instruments in one convenient window. When you use this view, the Spectrogram, Spectragraph and Oscilloscope instruments have linking buttons that allow you to either stereo link **SLink** the control parameters between the left and right channel instruments, or to link **Link** the control parameters of the Spectrogram and Spectragraph of the same channel. These linking buttons are very similar in concept to the link feature that appears on good-quality stereo compressors. For example, the stereo link button on the Spectragraph allows you to ensure that both the left and right channel Spectragraph instruments use the same frequency calibration. When instruments are stereo-linked, the parameters for both channels can be controlled from either the left or right channel details window. These linking features are currently only available in the Real Time Rack consolidated view.



Real Time Rack Consolidated View

You may move instruments within the rack by clicking on the instrument you want to move and dragging it to a new location. As you drag the instrument around, the rack will indicate places to which the instrument can be moved by drawing a heavy border around the empty spot. If you release the mouse button while the instrument is over a location that is already occupied, the instrument will automatically return to its original location. Moving an instrument within the rack does not interrupt the analysis process or even the display update. In fact, whenever you turn a knob or move a fader in SpectraFoo, everything responds instantaneously.

SpectraFoo Standard Equipment

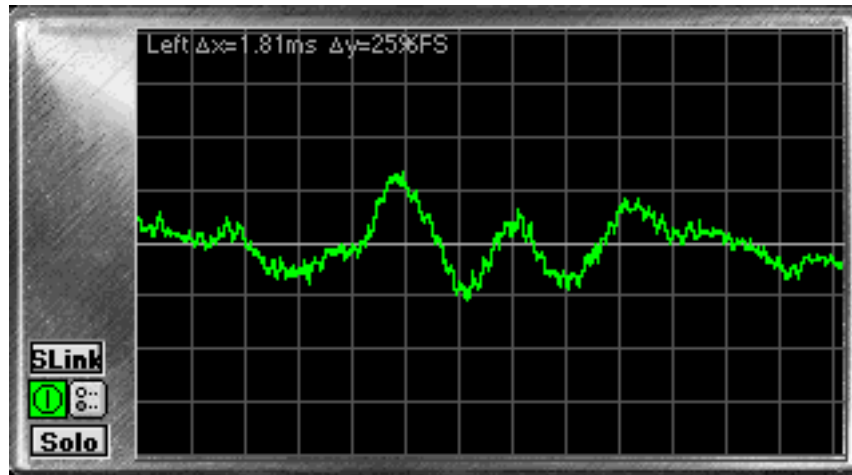
The screenshot shows the 'Power Meter Details' window. At the top, there are two digital level meters for 'Left' and 'Right' channels. The 'Left' meter shows a peak of -0.68 dB and an RMS of -4.25 dB. The 'Right' meter shows a peak of -0.80 dB and an RMS of -4.60 dB. Below the meters is a 'VU' section with a settling time of 3.090 s. There are three sliders: 'Meter Ballistics' (set to VU), 'Meter Scaling' (set to 3.00 dB), and 'Tick Spacing' (set to 3.00 dB). A 'Reset Peak Holds' button is located at the bottom of the window.

- These provide instantaneous numerical readings of the Peak, RMS, and VU levels with 0.01 dB accuracy.
- Click this button to pop up the Power Meter Details window
- Clicking this button resets the Peak and RMS Peak Holds.
- This slider controls the size (in dB) of the individual segments of the meters. Moving the slider to the right decreases the size and moving it to the left increases the size.
- This slider controls the scaling used by the power meters. When the slider is all the way to the right, the meters read down to -120dB. When the slider is all the way to the left, the meters read down to -15dB and show more detail in the upper power range.
- This slider controls the settling time of the VU part of the power meter. When the slider is all the way to the right, the VU meter behaves in a manner similar to the RMS meter. When the slider is aligned with the VU mark, the ballistics closely approximate the VU standard. When the slider is all the way to the left, the ballistics are much slower than traditional VU and behave like a long-term average.

Digital Level Meters (Peak, RMS and VU meters w/ Clipped Sample Counter)

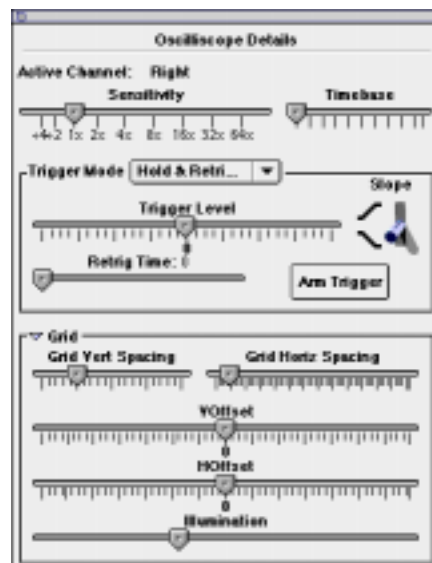
This is a two-channel three-in-one digital level meter. You may choose which analyzer channels to route to the meter with the **Active Channel** popup menus in the details window. The meter uses color to distinguish its different modes. The yellow part of the meter indicates the instantaneous peak to peak level of the program material. The purple part of the meter indicates the RMS level. The Peak and RMS meters each have independent, resettable peak hold functions. The peak holds are represented by triangular caret of the same color as the meter to which they correlate. The

VU meter is actually an adjustable ballistic average indicator that is represented by the grey triangular carets. Detailed meter readings (1/100 dB accuracy) and scaling options can be accessed by clicking on the Show Details button. The meter also contains a numerical counter that indicates the largest number of consecutive samples surpassing 0dBFS. The calibration of the meters is referenced against 0dBFS.



Triggering Oscilloscope

The oscilloscopes are single-trace-style scopes which provide a display of the program waveform of the assigned input channels. Pressing the preferences button on the oscilloscope brings up a details window that allows you to control several adjustable features, such as trigger mode. If the oscilloscope is contained within the Real Time Rack you can Stereo link the two oscilloscopes with the SLink button on the left channel scope. When you click the SLink button, the control parameters for the right channel scope are set to the corresponding values from the left scope.



With in the Oscilloscope details window the **Sensitivity** slider controls the magnification of the oscilloscope trace, allowing you to see the wave shape characteristics of very low level signals. The **Timebase** slider controls the timescale of the oscilloscope grid. The timebase of the grid is precisely indicated in the numerical readout at the top of each scope. Each mark on the slider indicates the number of samples represented by each pixel in the trace.

Each oscilloscope can trigger and hold the wave form of the signal being monitored. There are seven available trigger modes:

- **Free** automatically retriggers on the internal clock;
- **Normal** triggers the drawing trace once channel input matches your trigger settings
- **Hold** triggers a drawing trace and holds the signal until rearmed
- **Hold and Retrigger** same as Hold, but the trigger is automatically rearmed
- **Timed Hold** same as Hold, but the trigger is automatically rearmed after the desired "retrigger time"
- **Polarity Check** same as Hold, but displays all the data prior to the trigger point and triggers on either polarity and either slope
- **Timed Polarity Check** rearms after the desired "retrigger time"
- **Clip Capture** same as Polarity Check but triggers when signal reaches full scale
- **Timed Clip Capture** rearms after the desired "retrigger time"

The **Trigger Level** slider sets the trigger threshold level in percent of full scale. 0 represents $-\infty$ dBFS. When the slider is to the right of 0 the scope will trigger on the positive portion of a full scale signal; when it is to the left it will the negative portion of a full scale signal will trigger will be traced.

The **Retrig Time** slider controls the amount of time that the system waits before retriggering when a "Timed" is mode selected.

The **Slope Switch** controls how the scope is triggered. When in the up position, the scope will trigger when the signal reaches the threshold level and is moving in a positive direction. When the switch is down, the trigger occurs when the threshold is reached and is moving in a negative direction.

The **Arm Trigger** button manually rearms the trigger.

Clicking on the **Grid** button causes the oscilloscope details window to expand and reveal controls for manipulating the oscilloscope calibration grid, or graticule.

The **Grid Vert Spacing** slider controls the vertical spacing of the horizontal grid lines.

The **Grid Horiz Spacing** slider controls the horizontal spacing of the vertical grid lines.

The **VOffset** slider controls the vertical offset of the trace zero line.

The **HOffset** slider controls the horizontal offset of the trace trigger point.

The **Illumination** slider the brightness of the grid. Sliding it all the way to the left shuts off the grid and the grid details readout on the scope.

Real-Time High Resolution Spectrum Analyzer (Spectragraph)

The spectrum analysis within SpectraFoo utilizes a multichannel, high resolution, real-time FFT engine. At its highest resolution setting, SpectraFoo utilizes 64k point FFTs, allowing you to see features with widths as small as $2/3$ Hz. SpectraFoo creates a new analysis up to 84 times per second, allowing you to see musical structure even at the highest tempos.

Although the Spectragraph excels at traditional applications such as analyzing the distortion characteristics of audio equipment, its true strength lies in its sheer speed. SpectraFoo's Spectragraph is fast enough to create a highly detailed, animated "movie" of sonic events. If you have been watching SpectraFoo monitor a favorite album of yours while reading this guide, you probably have already noticed this.

Because the Spectragraph is so completely synchronized with the material it is monitoring, the information it displays can be experienced in a sensory rather than intellectual way – much the same way as you experience music itself. The key to making the most out of the Spectragraph (as well as all of the other instruments) is to spend some time listening to and looking at your favorite music – music that you know really well. After a relatively short amount of time, details of the recordings such as phase structure, overall spectral balance, dynamic range, frequency range, and low frequency roll-off will literally leap out at you. You will be experiencing, rather than thinking about, quantitative analysis.

The image shows the 'Spectragraph Details' window with several annotations pointing to its features:

- Checkboxes:** 'Peak', 'Instantaneous', and 'Average' are checked. A 'Reset Peak Holds' button is also present.
- Meter Ballistics:** A slider is shown with a 'Settling Time' of 12.552s.
- Frequency Scaling:** A slider for adjusting the frequency scale.
- Power Scaling:** A slider for adjusting the power scale.
- Frequency Range:** A slider showing a range from 0 Hz to 22.05 kHz.
- Power Range:** A slider showing a range from -98 to -4.
- Traces:** Three traces are visible: a bright green trace (Instantaneous), a purple trace (Average), and a dark green trace (Peak).
- Buttons:** 'Solo' and 'SLink' buttons are located at the bottom left.

Annotations provide the following information:

- These checkboxes show and hide the traces, allowing you to focus your attention on any combination of traces.
- Click the close box to close the Details window.
- Click to reset the peak trace.
- Gives a precise numerical reading of the settling time of the average trace.
- The Frequency Scaling and Power Scaling sliders allow you to adjust the scaling of the frequency and power calibrations. When the slider is set to its far left limit, the scale is roughly linear. When the slider is set to its right limit, the scale is logarithmic. The best way to get a feel for scaling, is to simply grab a slider and move it back and forth. The frequency and power calibrations will track your movements in real-time and useful scaling settings will quickly become obvious.
- Peak Hold Trace: Displays the maximum amplitude per frequency bin since the peak hold was last reset. To reset the peak hold either click on the instrument itself or click on Reset Peak Holds in the details window.
- Instantaneous Trace: Displays the current level of the signal at each frequency.
- AverageTrace: Displays the average level of the signal at each frequency.
- Use these sliders to change the low and high frequency limits that the spectragraph applies to its display. This lets you zoom in on a particular frequency range. As you change the low and high frequency limits, the frequency calibration on the bottom of the spectragraph will instantly rescale itself.
- Use these sliders to change the low and high power limits that the spectragraph applies to its display. This lets you zoom in on a particular power range. As you change the low and high frequency limits, the power calibration on the left side of the spectragraph will instantly rescale itself.
- Click on this button and the Spectragraph Details window will pop up above the instrument.

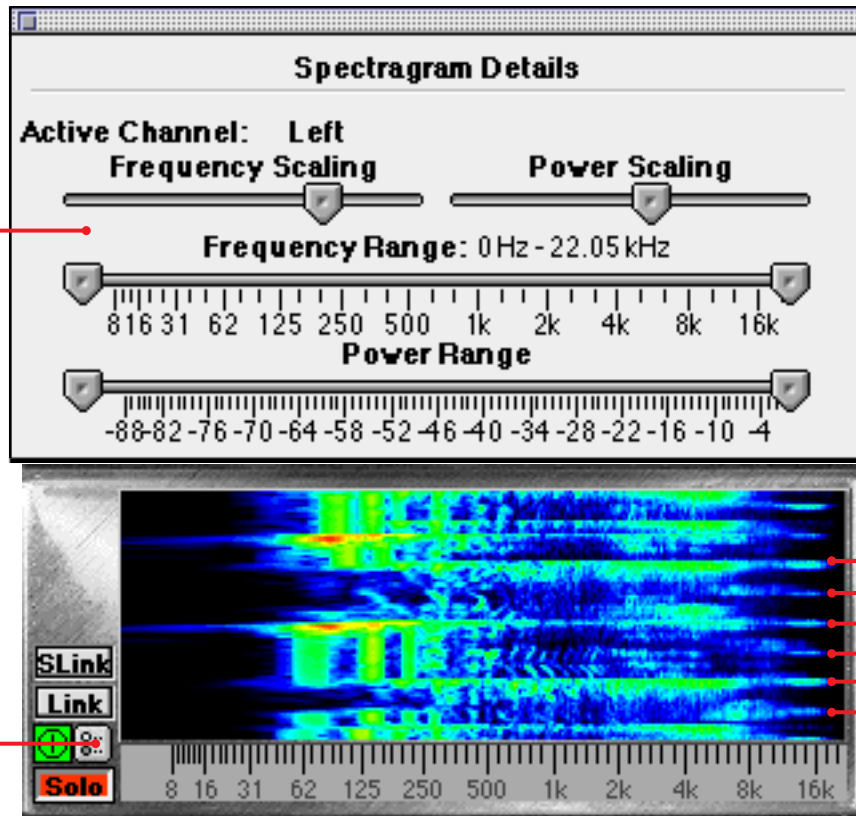
The Spectragraph utilizes a triple display. The bright green trace provides instantaneous spectral analysis. The purple trace shows the average spectral content referenced over a user specified length of time; this is controlled from the Details window. The dark green trace represents the peak spectral power monitored since the peak was last reset. Using the Details window, you can alter the Spectragraph's frequency and power scaling as well as its averaging characteristics in realtime. This allows you to focus on very fine details easily.

Real-Time Spectral Power History (Spectrogram)

The Spectrogram utilizes the same FFT resolution and scale as the Spectragraph. The display medium correlates not only frequency and power, but also time. The result is a visual "sonic fingerprint". Like the Spectragraph, the true

power of this instrument lies in its synchronization with the live audio signal. After spending some time “calibrating your eyes to your ears” by watching the Spectrogram while listening to music which is intimately familiar, the instrument literally becomes a waterfall of musical information.

These Range and Scaling sliders function exactly the same way as the sliders in the Spectrogram Details window.

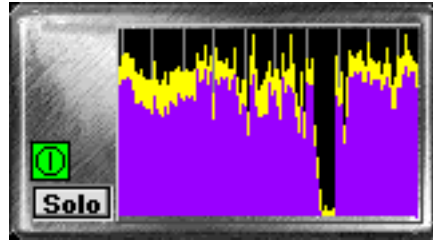


Click on this button to popup the Spectrogram Details window.

These evenly spaced marks are hi-hat hits. Because the spectrogram correlates frequency, power and time it is very useful for identifying timing discrepancies. When there are timing problems in dense arrangements, the Spectrogram can help you pinpoint the instrument or section that is causing the problem.

This tool is very effective for precisely identifying frequency overlap and masking effects, such as a bass drum track and a bass track occupying the same frequency range and obscuring each other. It gives you a good picture of the rhythmic aspects of program material and is very helpful in pinpointing timing problems in dense arrangements.

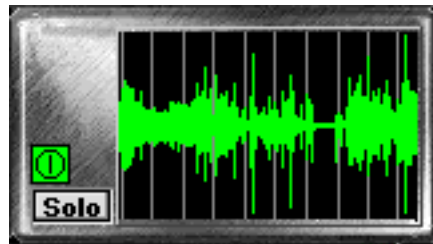
The Spectrogram represents the power of frequency events through a color scale. Although the illustration above does not show it, the Spectrogram Details window now has a color <—> power calibration bar that allows you to quickly determine the power of different events.



Peak and RMS Power History

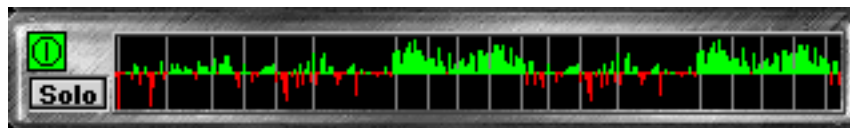
This instrument allows you to see the history of the information displayed by the Peak and RMS meters. The light grey “tick” marks indicate the passage of one second of time, and the height of the each color for each time “slice” indicates the Peak (yellow) & RMS (purple) power levels of the program. The ratio between these two levels is responsible for the “perceived” volume” of program material. When there is a large difference between the Peak and RMS levels of program material, the perceived volume will be low as compared to the peak levels on the tape. Conversely, when the difference between Peak and RMS levels is small, the perceived volume will be louder. This instrument can help you determine how much compression and limiting is needed for specific program material. If you have a full-featured mastering compressor, this display can also help you determine whether the compressor should be set to react to Peak or RMS levels.

Note: This meter is scaled logarithmically in decibels. When the average level is high, the signal can change relatively dramatically in level without creating a large change in the display. In this situation it is useful to refer to the envelope history display which is described below.



Envelope History

This instrument is a sample–editor–style scrolling envelope overview. It can help you calibrate your eyes if you are experienced with DAW-style displays. Because it uses linear scaling, it is useful for identifying large level changes when the average level is high. It should be used in conjunction with the Peak and Average History display to obtain a good view of the overall dynamics of program material.

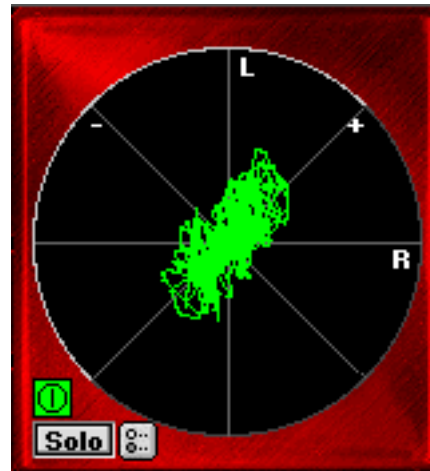


Power Balance History

The Power Balance History compares the power balance between the two input channels as a function of time. When the power level on the first input channel is greater than the second input channel the display turns green and shifts above the centerline. When the power level on the second input channel is greater than the first input channel, the display turns red and shifts below the centerline. The length of the indicator expresses the difference in power between the right and left sides as a percentage of the total power present in both signals. The light grey lines appear once per second as the history scrolls to the left. This meter is very helpful for precisely identifying the aspects of mixes that don’t have a natural flow of energy between the left and right channels. It is also great for power-balancing natural stereo recordings and two channel measurements of equipment.

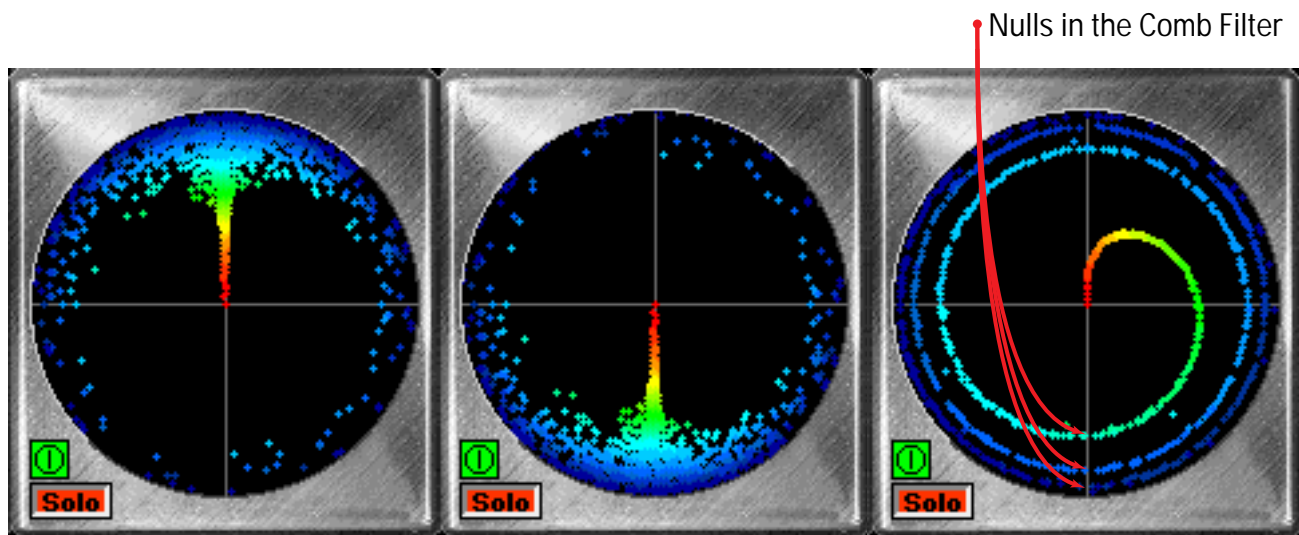


Lissajous Phase Scope (vector mode)



Lissajous Phase Scope (X-Y mode)

The Lissajous Phase Scope is equivalent to an oscilloscope running in either vectorscope or X–Y mode (You can switch the mode by <option>-clicking the instrument). It shows you the amplitude of the first input signal versus the amplitude of the second input channel signal. This instantly lets you know if a mix has polarity problems. It also allows you to see the width of the stereo field of the material being monitored. When the scope is in vector mode, in-phase material appears as a vertical line while out of phase material appears horizontal. When the scope is in X–Y mode and the activity of the trace occurs mostly in the lower left and upper right quadrants of the display (as pictured) the left and right channels are predominantly in polarity. When the activity of the trace occurs mostly in the lower right and upper left quadrants of the display, the left and right channels are predominantly out of polarity (commonly referred to as out-of-phase, or mono-incompatible).




In phase

Out of Polarity

Inter-channel delay

Phase Torch™

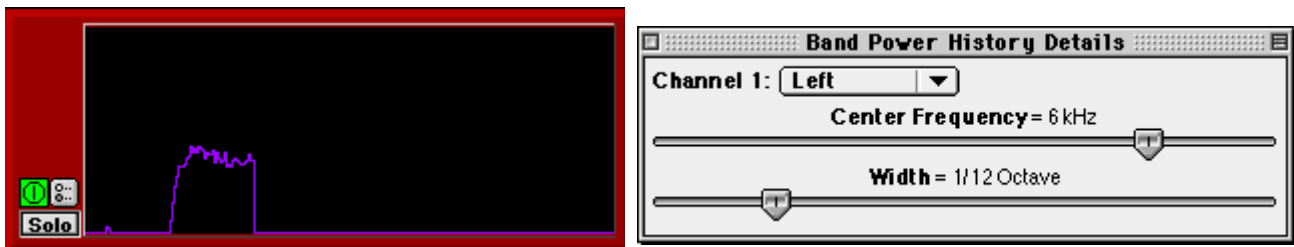
This is a revolutionary new tool which compares the phase difference between two channels as a function of frequency, independent of power. The display looks like a multicolored fountain or torch. The graphing scheme is a polar pattern. The radius from the center is determined by the frequency and the angle is determined by the phase difference between the left and right channels. The center of the graph represents DC while the outer radius represents 22 kHz .

In order to help you intuitively identify the frequencies, the phase points are also colored according to their frequency. You can get a color – frequency calibration chart by clicking on the Phase Torch’s parameter control button . A mono (in-phase) signal is indicated by what looks like a torch precisely aligned with the Y axis of the scope. The in-phase torch illustrated above “fuzzes-out” at high-frequencies because the signal used to create the display did not have very much high frequency energy so the display is dominated by noise at high frequencies. An out-of-polarity signal appears as a negative version of a mono signal. Delays appear as spirals within the scope.

This meter is very useful when recording a musical instrument with multiple microphones. You can use the Phase Torch to identify the frequency ranges in which phase cancellations are occurring as a result of the comb filter created by the use of multiple mics on a single source. Phase points that are oriented on the negative Y axis of the meter represent the null points of the comb filter. This can help set up multiple microphone placements that create nulls which are outside of the critical frequency range of the instrument you are recording.

The Phase Torch can also be used as a very quick and elegant troubleshooting tool for identifying phase anomalies in studio wiring. If you suspect a phase compensation or delay problem between multiple audio paths in your studio, simply run a common signal into two paths and route one to SpectraFoo’s left input and the other to its right input. If a phase problem exists, the Phase Torch will display it immediately. The Phase Torch is also effective for a number of other applications including:

- Setting azimuth on analog tape recorders
- Checking for time alignment in complex PA systems
- Identifying frequency dependent phase and polarity problems (such as an out of polarity high frequency driver in a sound reinforcement system).
- Frequency sensitive mono compatibility analysis



Band Power History

This instrument allows you to see the history of the amount of power in a specified band of the spectrum. The instrument’s details window allows you to set the center frequency and the bandwidth of the power band that you are interested in monitoring. The preset values for this instrument are 1/12 of an octave at 6kHz. This allows it to function as a very effective sibilance meter.



Timecode Clock

The timecode clock can lock to external timecode sources such as tape machines with SMPTE, the Alesis BRC, Tascam SY88, and MOTU MTP-AV or any other device capable of producing MIDI Time Code. In addition, the clock can lock to the computer’s internal clock or the computer’s CD drive. You can select between the different timecode sources by clicking on the radio buttons under the timecode readout. The format of the timecode readout is the standard SMPTE HH:MM:SS.FF. SpectraFoo will reference all recorded captures to timecode.

Quick Menu Reference

Edit	Analyzer	Audio I/O	Captu
Undo			⌘Z
Cut			⌘X
Copy			⌘C
Paste			⌘V
Clear			
Select All			⌘A
Show Clipboard			
Allow Background Apps to Run			
Preferences...			

Edit Menu This menu contains the standard editing commands. Currently **Select All** and **Show Clipboard** are not implemented. The **Allow Background Apps to Run**, when selected, causes SpectraFoo to yield time to other applications running on the computer. The state of this command is remembered as a preference. By default, SpectraFoo takes up as much time as possible on the computer. You may want to select this command if you are running other audio applications or other programs that do background processing. If you do select this command, you can expect the update rate of the instruments to decrease slightly and you may find that the instruments will pause occasionally.

The **Preferences** command allows you to bring up system-wide preferences for SpectraFoo. Currently, these preferences allow you to control the visual appearance of the components of SpectraFoo. In order to change the panel color you must have the “ColorPickerLib” installed in the extensions folder. This library comes standard with the Macintosh System Software. If this file is not installed, when you click on the **Panel Color** color tile, nothing will happen. The **Used brushed metal panels** check box controls the appearance of the panels that appear within the Real Time Rack consolidated view. Finally, the **Panel Hilite Tints** sliders allow you to adjust the brightness of the highlights and shadows on the instrument panels.



All changes that you make with this control panel are remembered as preferences. These changes take place immediately.

Analyzer	Audio I/O	Cap
1024 Pt (40Hz)		
2048 Pt (20Hz)		
◆ 4096 Pt (10Hz)		
8192 Pt (5Hz)		
16k Pt (2.7 Hz)		
32k Pt (1.3 Hz)		
64k Pt (0.7 Hz)		
Remove DC Offset	⌘B	
Reset Analyzer	⌘Y	

Analyzer Menu Although you can switch the resolution of the analyzer to less than 4096 points, SpectraFoo is so fast that we can't see why you would want to (if the computer you are using is especially slow, or if it does not have *any* cache, you may want to lower the analyzer resolution in order to gain some speed at the expense of frequency resolution). You can also use this menu to increase the resolution of the analyzer. The **8192pt** setting is a good compromise between speed and resolution on fast machines.

The **Remove DC Offset** command allows you to remove any residual DC offset from the input converters. If the Spectragraph shows a hump at 0 Hz, even with no input signal present, mute the input to SpectraFoo and select the **Remove DC Offset** command to remove the DC offset from the input.

The **Reset Analyzer** command causes the analyzer to disconnect and the reconnect itself from the selected input hardware. It can be used if the system appears to be behaving strangely (No instrument updates, or severe digital distortion).

Audio I/O	Captures	Gro
Monitor Input		⌘I
✓ Use Internal Clock		
InternalMic		
Expansion Bay-PC Card		
◆ Line In		

Switching Sources: The Audio I/O Menu. The items that appear in this menu will depend on the particular hardware configuration that SpectraFoo is running on. SpectraFoo gets information about available input paths from the Sound Manager of the MacOS. The items in this menu will reflect the particular hardware configuration of your computer. If you are using any supported third-party I/O cards they will appear in this menu. These cards can be selected and controlled directly using the Audio I/O menu.

The **Monitor Input** command allows you to control how the software passes audio from its input to its output. If this item is checked, the audio will be passed. If it is unchecked, the audio will be muted. If you are using the built in mic on a portable computer and are also using the built in speakers, this item must be unchecked, or you will encounter feedback. If you have selected the audio playthrough feature of the sound manager and this item is selected you will experience an "echo" in the audio output. This can be resolved by unchecking this item, or deselecting the playthrough feature in the sound manager.

Note: With system 8.1 and with all G3 Macs, the sound manager automatically enables playthrough. You can disable it by selecting None as the sound source in the sound manager and then selecting the desired sound source in SpectraFoo.

The **Use Internal Clock** command allows you to choose between an internal and external clock source for the currently selected input hardware. If the hardware supports changing the clock source, this command will be enabled. Generally, you will want to use an external clock if you are recording or monitoring a digital input signal. You may want to use the internal clock when you play material from a capture. Sound Manager input paths always use the internal clock.



Captures Menu The Captures menu is used to control the Capture List Window which is described later in this Manual. You can use the commands in the Captures menu to Load, Save, and Delete Captures. You can also tell SpectraFoo to warn you if it is about to remove an unsaved capture from the system's memory.

The **Save Selected Captures** command will save all of the captures that are currently selected in the Capture List Window. If any of the selected captures have not yet been saved to disk, you will be prompted for a name and location to save the file.



You can use the **Trim Audio to Loop Points** in the save dialog to cause SpectraFoo to save only the audio between the start and end loop points of the capture. This provides a convenient method to destructively trim audio files.

The **Save Selected Captures As** command will allow you to save each of the currently selected (in the Capture List Window) captures to a fresh location or with a fresh name. You will be presented with the save dialog for each capture in turn.

The **Load Capture** command allows you to load any AIFF or SoundDesigner II file as a capture.

The **Delete Selected Captures** removes the selected (in the Capture List Window) captures from SpectraFoo's memory. If the **Ask About Unsaved Captures** command has been selected, for each capture that has been changed and is being deleted, SpectraFoo will ask if you want to save the changes. A capture that has never been saved is considered to be changed.

The **Ask About Unsaved Captures** command, when checked, causes SpectraFoo to ask you if you want to save a capture that has been changed or has never been saved before it is deleted from memory. The state of this command is remembered as a preference. You may want to turn this off if you have made a large number of captures and want to delete them all or quit SpectraFoo without being asked about each capture in turn.

Groups	Window	Help
Add to Group Library...		
Delete from Group Library...		
All Off		⌘0
Spectral Monitoring		⌘2
Phase & Balance		⌘3
Histories		⌘4
All On		⌘1

Groups Menu The groups menu allows you to control and select from the library of instrument enable groups. Instrument enable groups allow you to take and restore snapshots of the state of the enable and solo buttons of all of the instruments in the Real Time Rack. Unfortunately the Instrument enable groups do not currently support instruments that are not in the Real Time Rack.

The **Add to Group Library** command allows you to take a snapshot of the current state of the buttons and save it into the library. A dialog will appear that allows you to name the Group. By appending a '/x' (where x is replaced with the command key that you would like to use) you can assign a command key to the group. For instance, the **All Off** group was defined with the name "All Off/0".

The **Delete from Group Library** command allows you to remove a snapshot from the library.

Selecting any of the items that appear below the separator line will restore the associated snapshot.

Window	Help	Sat 6:30
Stack Windows		
Tile Windows		
Hide All Floating Controls		⌘H
Hide Routing Window		⌘T
Hide Master Control Window		⌘M
Show Capture Control Window		⌘R
Show Capture List Window		⌘L
Show FFT Window Control		⌘E
✓ Oscilloscope: Left		
Digital Level Meters - Left, Right		
Spectragraph: Left		

Window Menu The window menu allows you to control the various windows that comprise SpectraFoo. The windows in SpectraFoo are in two different layers. These two layers consist of instrument windows and control windows that float above the instrument windows.

The Control and Routing window, Master Control window, FFT Window Control window, and the all the Details windows for the real time instruments are control windows. Instrument windows are used to display actual measured data. The Real Time Rack is also an instrument window, Control windows always stay in front of the Instrument windows.

In order to help you manage the windows and reduce screen clutter, SpectraFoo provides a set of menu and keyboard commands.

The **Stack Windows** command re-arranges all of the windows in the instrument layer by stacking them diagonally from the upper left hand corner of the main screen.

The **Tile Windows** command is not implemented in this version of the software.

The **Hide All Floating Controls** provides an easy way to remove screen clutter by hiding all of the floating control windows at once. If no floating controls are visible, this command becomes **Show All Floating Controls** which makes all of the hidden floating control windows visible.

The next group of commands, **Hide Routing Window ... Show FFT Window Control**, all toggle the visibility of the indicated control window.

The last group of items in the menu correspond to the list of windows in the instrument window layer. Selecting one of these items will bring the corresponding window to the top of the instrument window layer.

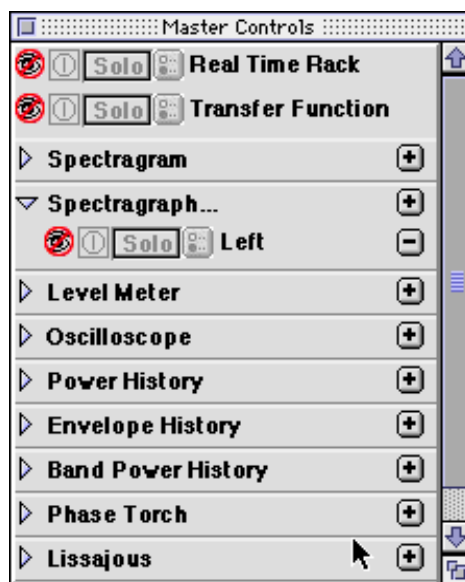
The various Control Windows are described in more detail later in the manual.

Controlling Audio and Instruments in SpectraFoo

When you start SpectraFoo the **Analyzer Control & Routing** and the **Master Controls** windows will appear.



The **Analyzer Control & Routing** window allows you to control the global properties of SpectraFoo's analysis engine. The **Master Controls** window allows you to add, delete and configure specific instruments.




The Master Controls Window

The Master Controls window contains two types of items: Instrument Classes and Instrument Controllers. Instrument classes contain a disclosure arrow \triangleright , the name of an instrument type such as spectragraph, level meter etc. and an add button \oplus . Instrument controllers contain (from left to right) a show/hide icon \square , an on/off button \square , a solo button Solo , a show details button [?] , a channel assignment, and a remove button \square . In the picture above, the Real Time Rack item is an example of an Instrument Controller and the Spectrogram item is an example of an Instrument Class.

To the right of each instrument class is an add button \oplus . Clicking this button adds another instance of the particular instrument to the system and creates a new instrument controller item. Click on the show/hide icon of the new instrument controller item and a free standing resizable window will appear containing the selected instrument.

Each instrument class can have many instances. You could, for example, create four Spectragraphs to monitor the left channel: one adjusted to monitor the entire audible spectrum, one zoomed in on low frequencies, another zoomed in on the midrange, and other focused on the high end. You could create another 4 instances set the same way but assigned to a different analyzer channel. Of course if you want the consolidated view provided by the virtual rack interface, simply click the show/hide icon for the Real Time Rack in the Master Controls window and SpectraFoo


will create a consolidated two channel metering view. To remove an instance of an instrument click on its remove button  in the Master Controls window. A dialog will appear as shown below:



If you wish to avoid this dialog option-click the remove button in the Master Controls window. The instrument will be immediately removed.

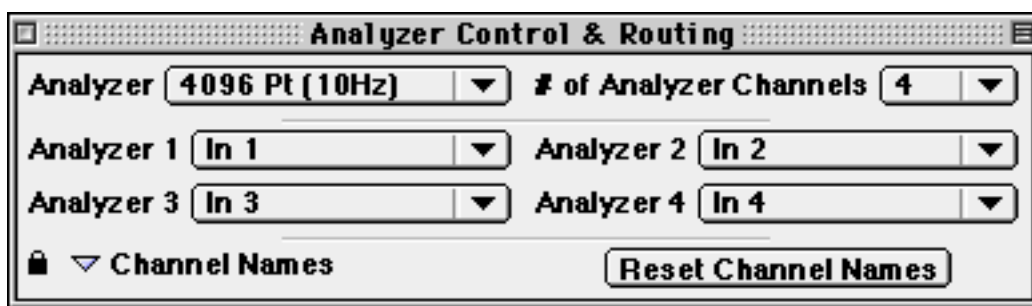
Channel assignment is controlled via the instrument's details window.



The details window is accessed by clicking the show details button  in either the Master Controls window or in the instrument itself.

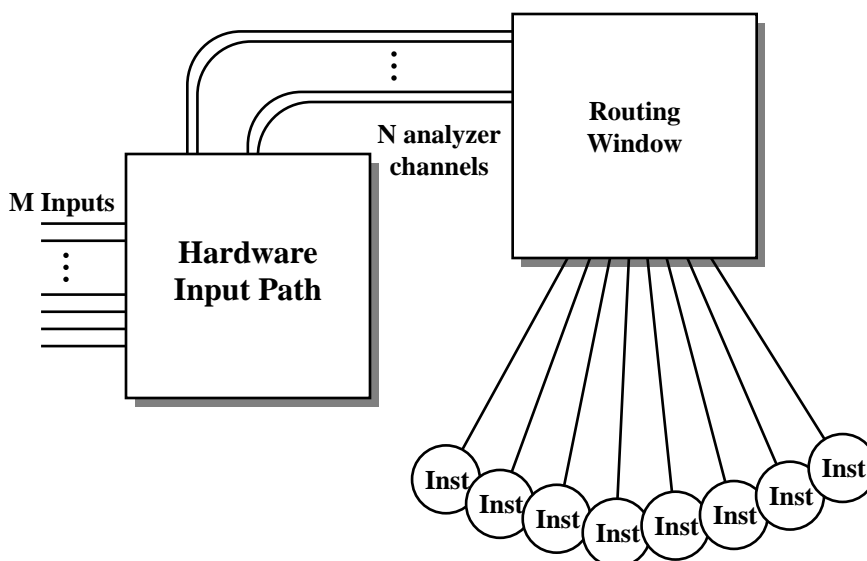
The Master Controls window allows you to have as much or as little analysis as you need. It also allows you to completely personalize your configuration. SpectraFoo remembers the configuration of windows and rack panels. After you have set up a personalized configuration, SpectraFoo will launch using that configuration until you make a change.

You can hide and show the Master Controls window from the Window menu.



Analyzer Control & Routing Window

The **Analyzer Control & Routing** window allows you to control SpectraFoo's global analyzer parameters and how signal is globally routed through the analysis system. SpectraFoo's analysis routing model has two layers for maximum flexibility. By selecting an audio input path from the Audio I/O menu you choose the audio Hardware that SpectraFoo uses to acquire the audio streams to analyze. Different audio cards have different channel capabilities. Sound Manager, PCI 24 and AudioMedia III all provide two channels of audio. The Korg 1212 I/O can provide 12 channels of audio simultaneously. SpectraFoo uses an internal M-> N routing matrix to allocate each of the N analysis channels to any of the M inputs. Each of the SpectraFoo instruments has an internal routing control that allows you to select one of the analyzer channels to feed the instrument. This process is illustrated below:



Although it seems a bit complicated in practice it is very flexible and quite easy to use.

Analyzer Channels

In SpectraFoo there is a difference between analyzer channels and analysis instruments. In SpectraFoo you can have many different types of instruments monitoring the same channel as well as many different versions of the same instrument monitoring the same channel. You can also monitor multiple channels simultaneously.

With the analyzer pop-up in the control and routing window you can set the number of channels you want to be able to monitor simultaneously. If you set the number of Analyzer Channels to 2 you will be able to actively monitor two channels of your from your input hardware at a one time. However, the number of analyzer channels within SpectraFoo and the number of hardware channels are independent. The number of hardware channels depends on the hardware input path that you are using. Once you have selected an input path you can route from any of the hardware the analyzer channels the fly, without stopping the audio using the analyzer channels pop-ups in the Control and Routing window (this is described below).

The number of channels you can analyze simultaneously is limited by the speed of your Macintosh. If you are using a G3 or 9600/300 you will be able to monitor 24 channels simultaneously with impressive update performance. If you are using a slower machine (603e, 604<200MHz) the update rate might appear sluggish.

The default number of analyzer channels for SpectraFoo is two. This will work fine on PCI-based PowerPCs. SpectraFoo is fully qualified to run at all channel depths on all G3-based Macs and 8600/9600/300 machines. If you do not have one of these machines it does not mean that you cannot run SpectraFoo. It just means that your machine might not support 24 channels of simultaneous analysis.

If you are interested in determining the upper limit of your computer's multichannel analysis capability you should start SpectraFoo at a non-critical time and step up the channel depth from the 2 channel default setting to six channels then to 8 and so on. Of course it makes no sense to increase the number of analysis channels to be greater than the number of hardware channels that are available. Each time you change the analyzer depth evaluate the performance of the analysis instruments. When the update of the instruments begins to get sluggish this is an indication that you are beginning to overtax your host processor. On some slower machines it is possible that 2 analyzer channels will be the maximum that is practical.

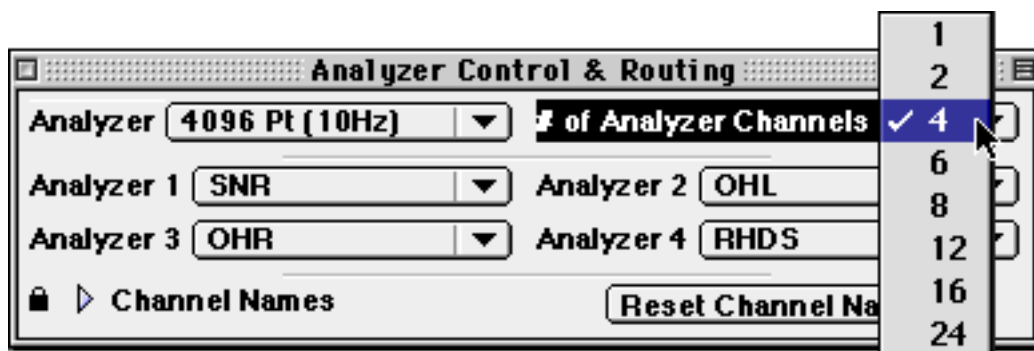
Truthfully, there are probably very few situations in which you would want or need to be analyzing 24 channels at the same time. It's hard to concentrate on that much different information at the same time plus most people don't have the screen real estate to accommodate 24 simultaneous Spectrum Analyzers! It is nice however to be able to look at 4-8 channels at the same time. A four channel example would be to use two channels to monitor the main LR

stereo mix and the other two channels to matrix switch on the fly between the individual channels of the mix. You could check out the kick drum and the bass for example to see if there masking effect inducing frequency overlaps that could be cured with EQ (remember you can pull up an EQ while continuing to monitor with SpectraFoo). Then you could switch to a stereo miked guitar and check out the phase relationship between the two channels, then switch to snare top and bottom etc. All of this matrix switching can be done without stopping playback.

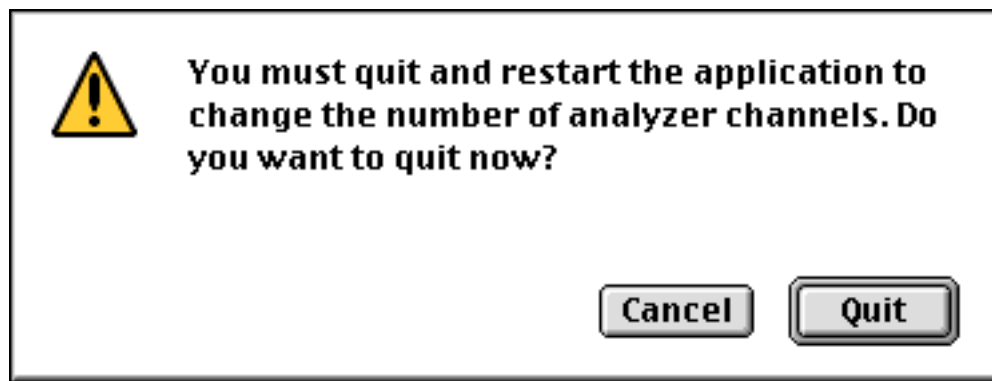
Adjusting the Number of Analyzer Channels

You can adjust the number of channels of simultaneous analysis available in SpectraFoo. There is a small trade-off between the number of channels and overall system performance. The more channels of analysis that you have, the more the system is loaded down. For best performance leave the number of channels in the 4-8 region. If you have a need to analyze more channels, by all means do so, but don't set the number of analyzer channels to a large number arbitrarily... you will get better performance by selecting that number of channels you actually need.

To change the number of analysis channels, simply select the number you want from the “# of Analyzer Channels” pop-up menu in the upper right hand corner of the **Analyzer Control & Routing** window.



Currently SpectraFoo has to restart in order to change the number of analysis channels. When you change the number of analyzer channels you will be presented with a dialog confirming that you want to restart SpectraFoo:



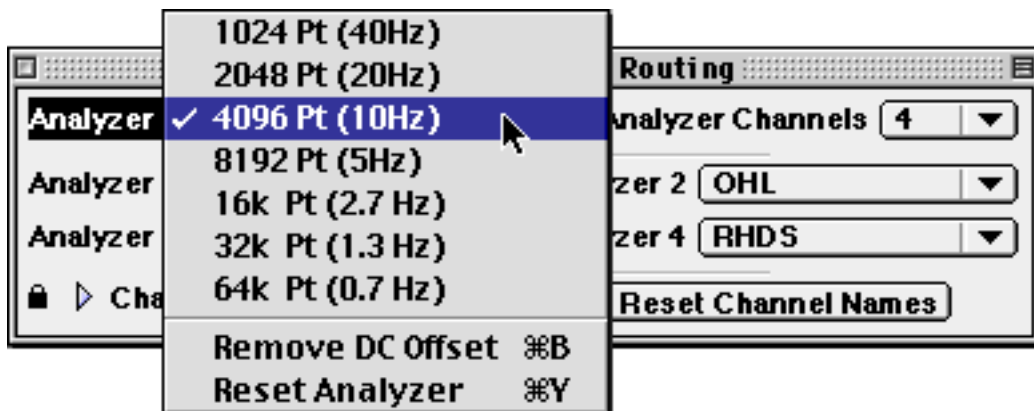
If you hit **Cancel** the number of channels will return to its previous setting. If you click the **Quit** button SpectraFoo will quit. To restart it, double-click on the SpectraFoo application; SpectraFoo will restart with the newly selected number of analyzer channels.

The number of analyzer channels is saved as a preference, so SpectraFoo will remember the number of analyzer channels each time it is started.

Changing the analysis depth

You can change the number of samples that SpectraFoo uses in its FFT analysis. Increasing the number of points increases the frequency resolution of the analysis (it allows you to see narrower spectral features - especially on the low end) but it tends to smear the high end in time and can lead to a de synchronization of the audio from the analysis. Metric Halo recommends using either a 4096 pt or a 8192 pt FFT Analyzer depth for music production work.

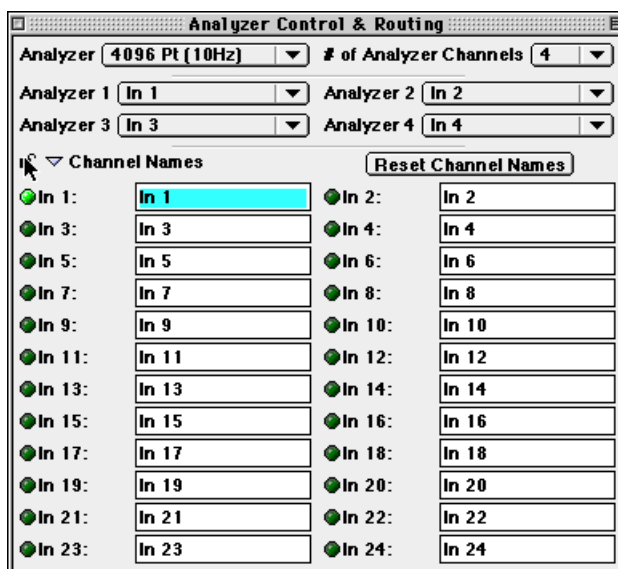
Changing the analyzer depth is simple. Just select the desired depth from the Analyzer popup menu in the upper left hand corner of the **Analyzer Control & Routing** window. The change take place automatically and instantly.



Configuring the routing matrix

Once you have selected your audio input path, you should configure the routing matrix to remove any ambiguity from the process of monitoring your audio. If your audio path is two-channel the default configuration is probably fine (Left Channel named Left, Right Channel named Right).

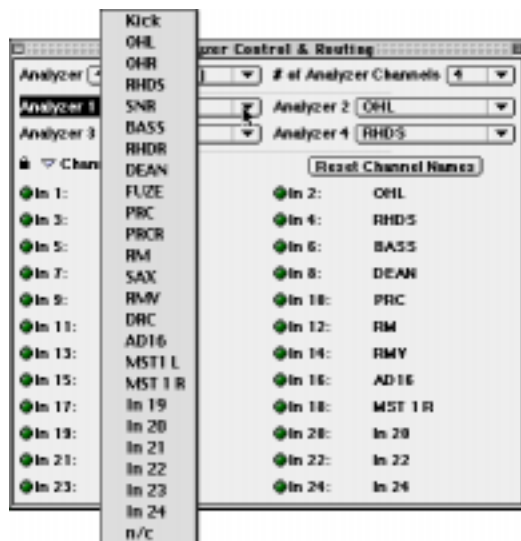
If you are using a multi-channel input path (such as the Korg 1212 I/O) The first step is to name the input channels. SpectraFoo provides a mechanism for naming the input channels. To access this mechanism, simply click on the small lock icon on the lower left hand corner of the **Analyzer Control & Routing** window. The window will expand to show the M input channel names. It looks like this:



You can type the proper input channel names into the edit text areas. The <tab> key will move the input focus to the next field. <command><tab> will move the input focus to the previous field.

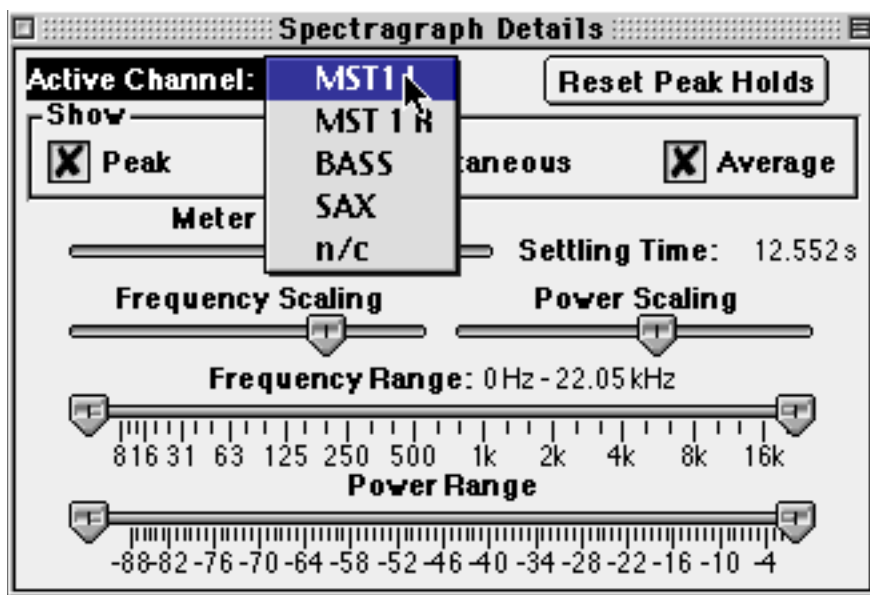
After you have named all of the channels that you are using, click the lock icon again. This will close the channel names and rename all of the channels within SpectraFoo. If you want to hide the list of channel names you can click on the Channel Names disclosure arrow and the window will shrink down.

Now that your input channels are named and you have an easy way to refer to them, you need to route the channels that you want to analyze to the analyzer. This is accomplished with the routing portion of the **Analyzer Control & Routing** window. Each analyzer channel has a popup menu associated with it. This menu allows you to select the name of the input channel that you would like to send to the associated analyzer channel.



The number of analyzer channels determine how many *different* channels you can analyze at once. If you need to analyze more channels at one time, see the section on changing the number of analysis channels. If you just want to quickly switch analysis to a different one of your input channels, use the analyzer channel popup menu. Note that you do not have to stop the transport to change the routing from within SpectraFoo.

Each instrument in SpectraFoo is assigned analyzer channel that it gets its analysis data from. The **Active Channel** popup menu in the control window of each instrument is used to select the instrument's source analyzer channel.

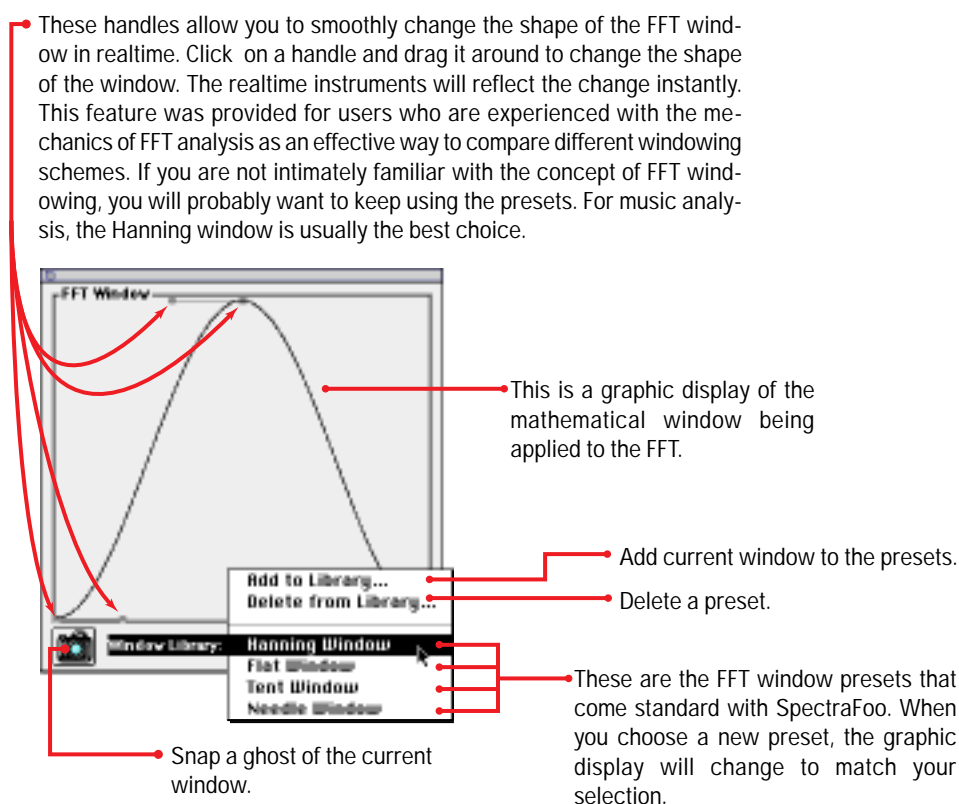


Once you have assigned an input channel to an analyzer channel the input channel's name is propagated throughout SpectraFoo. So, as you see above, the channel names that appear in the instrument **Active Channel** popup menu are those of the input channels that have been associated with the analyzer channels.

If you change the input channel associated with an analyzer channel, all of the instruments that are assigned to the analyzer channel will update automatically.

This two-layer mechanism works extremely well when you have a large number of source tracks that you want to alternately apply the same type of analysis to. For example, let's say that you are mixing from a 24 track master. It is unlikely that you would need or even want to do spectrum, level and phase analysis on all 24 channels at once. But you may want to set up 4 clusters of instruments with each cluster assigned to a different analyzer channel. You can easily switch any cluster to any of the 24 master channels by using the analyzer routing control. Any of the channels is just a click of the mouse away.

Controlling the FFT Window



FFT Window Control Window

The FFT assumes that the block of samples it is operating on is periodic. That is, it assumes that if the block of samples was to be repeated in a loop, it would form a smooth and continuous repeating waveform of some kind. Unfortunately, music is neither completely periodic nor completely random. If an FFT is performed on a group of samples taken from non-periodic material, spurious data results from the discontinuity at the boundary between the last sample and the first sample of the block. Windowing helps to remove the spurious data by "feathering" the edges of the group of samples so that the group becomes periodic and continuous at the boundary.

The FFT Window Control Window allows you to adjust the shape of the windowing function used in SpectraFoo's FFT analyzer. These adjustments can be done in real-time, allowing you to see their effects as they happen. The Window Library popup menu allows you to select from a set of preconfigured FFT windows and it also allows you to save your own windows for recall. The FFT Window Control Window is accessed by using the Window Menu.

Capture and Storage

SpectraFoo provides the ability to record selections of audio into the computer's RAM and perform incredibly detailed non-real-time analysis. All captures are referenced to the timecode of the source material. Captures may be initiated manually or can be triggered automatically, either with a level-based trigger or a time-based trigger. The start and stop times for the most recent recording are retained and can be used to record material that occurs at the same time with respect to the external timecode source. You can use this to grab multiple aligned tracks of audio or to record the same audio with different types of processing. All recording is controlled and initiated with the Capture Control window. There are three basic capture modes that you may use. You may select among these modes by clicking the appropriate radio button.

1. Manual

Use manual mode to record on the fly. Click the record button to start recording and click it again to stop recording.

2. Timecode-based auto-punch

Use timecode-based auto-punch to record a segment of audio that starts at a particular time and ends at another time. This is like the auto-punch feature of many tape decks. Simply type the start and end times into the punch in and punch out fields and click the Record button. SpectraFoo will arm its auto-punch mechanism and wait until the timecode clock matches the punch-in time. It will then record until the timecode clock matches the punch-out time, and automatically stop.

3. Level-based auto-punch.

Use level-based auto-punch to start and stop recording based on the volume of the audio being monitored. This is great for capturing individual drum beats or for capturing entire songs. A specific example of the usefulness of level-based captures is when you are trying to determine the optimal placement of microphones on a drum kit. When coupled with the Auto Arm feature, level-based punches can be used to capture individual drum beats in a hands-free way, allowing you to devote your attention to placing the mic, while still benefiting from SpectraFoo's analysis.

Select one of the 3 recording modes by clicking the appropriate radio button.

Click this checkbox to enable automatic recording using timecode or envelope (level) based triggering.

This handle lets you set the trigger level and the pre-trigger time. When the input signal exceeds the trigger level the system starts the recording from the trigger time minus the pre-trigger time. This ensures that you will not miss any of the initial transients in the material you are trying to capture.

This handle lets you set the de-trigger level and the post-de-trigger time. This allows you to specify the amount of time that SpectraFoo will continue recording before checking the signal level to determine if it is below the de-trigger level. The vertical position of the handle sets the de-trigger level and the horizontal position sets the post de-trigger time.

This handle allows you to set the length of time that the signal must remain below the de-trigger level to cause the system to stop recording.

Because SpectraFoo uses memory to buffer the audio stream, it can actually include data in a capture that occurs before the level threshold is surpassed. This insures that the initial transients of impulsive sounds will not be missed.

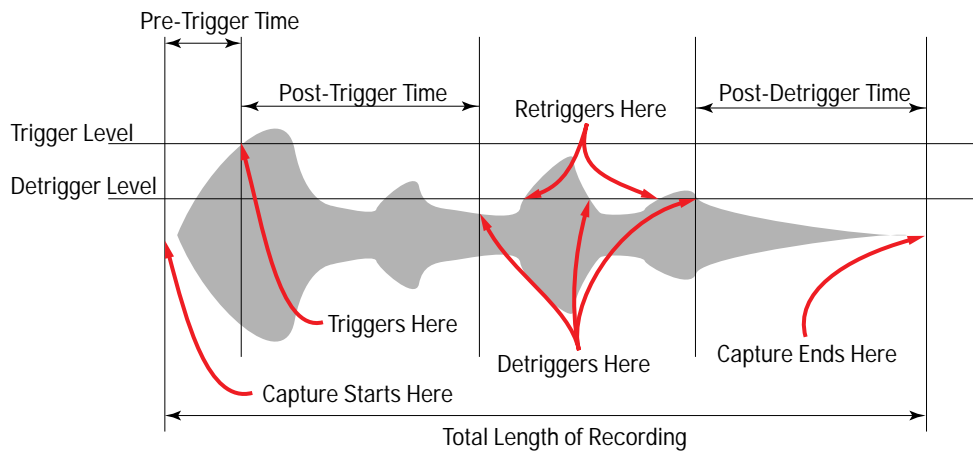
These fields allow you to set the punch in/out timecode values. See the control summary for details on how to use the timecode fields. The cursor can be moved between the punch in/out fields with the mouse or the tab key.

This indicates the level threshold that will de-trigger recording.

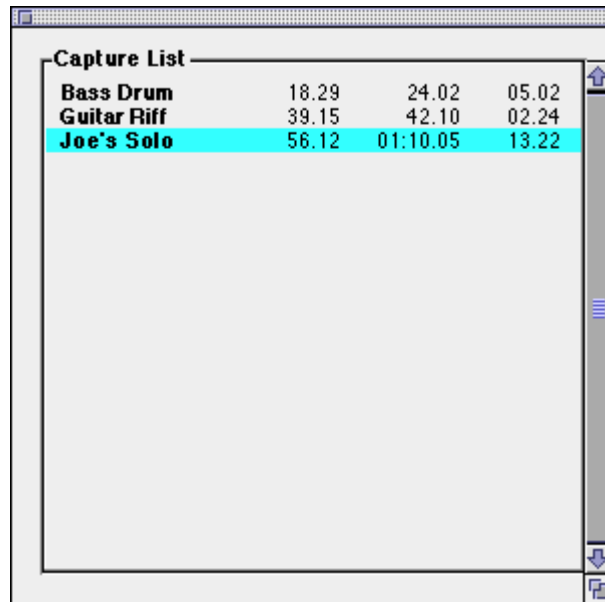
This indicates the level threshold that will trigger recording.

The screenshot shows the 'Record Enable' window with the following settings:

- Record Enable:** Left Channel, Right Channel
- Available Time:** 00:01:46.11|0658
- Use Envelope:** (selected), Auto Arm
- Trigger Envelope:** A graph showing a signal level that rises above the Trigger Level, then falls below the Detrig Level, and then rises again above the Trigger Level.
- Pre-trig time:** 00.09, **Trig Lvl:** -1.9 dB (80%)
- Post-trig time:** 01.15, **Detrig Lvl:** -14.0 dB (20%)
- Post-detrig time:** 01.06
- Use Timecode Punch In/Out:** (selected), **Punch In:** 00:00:00.00|0000, **Punch Out:** 00:00:00.00|0000
- Manual Punch In/Out:** (selected)
- Buttons:** Stop, Record



All captures are retained in RAM to assure the highest processing speed and complete random-accessibility. A list of the captures that are currently available is maintained in the Capture List window. The Capture List maintains a library of the captures that are currently loaded into RAM. Clicking on a capture name selects it. Double clicking on a capture in this list opens a Capture Overview window which will be described later. The Capture List window behaves like a standard Macintosh list. You can use the shift and command keys to make multiple selections. If you have multiple captures selected and double click, a Capture Overview window will open for each selection.



Capture List Window

Captures can be saved to disk as AIFF files and SpectraFoo can import AIFF files as captures using the commands in the Capture menu.

Capture Overview Windows

The recorded information can be further analyzed and manipulated via the Capture Overview windows. Captures can be removed from memory to reclaim the space for more recordings. The total length of captured material is limited only by the amount of RAM in your system.

Once you have opened a Capture Overview window by double-clicking on one of your captures in the capture list window, you can examine various timecode-locked historical representations of the capture, including the envelope, the power balance, the peak and average level, and the spectral power history. You can “slice” the capture at any instant of time to display the instrument analysis of the signal at that instant in all of the real-time instruments.

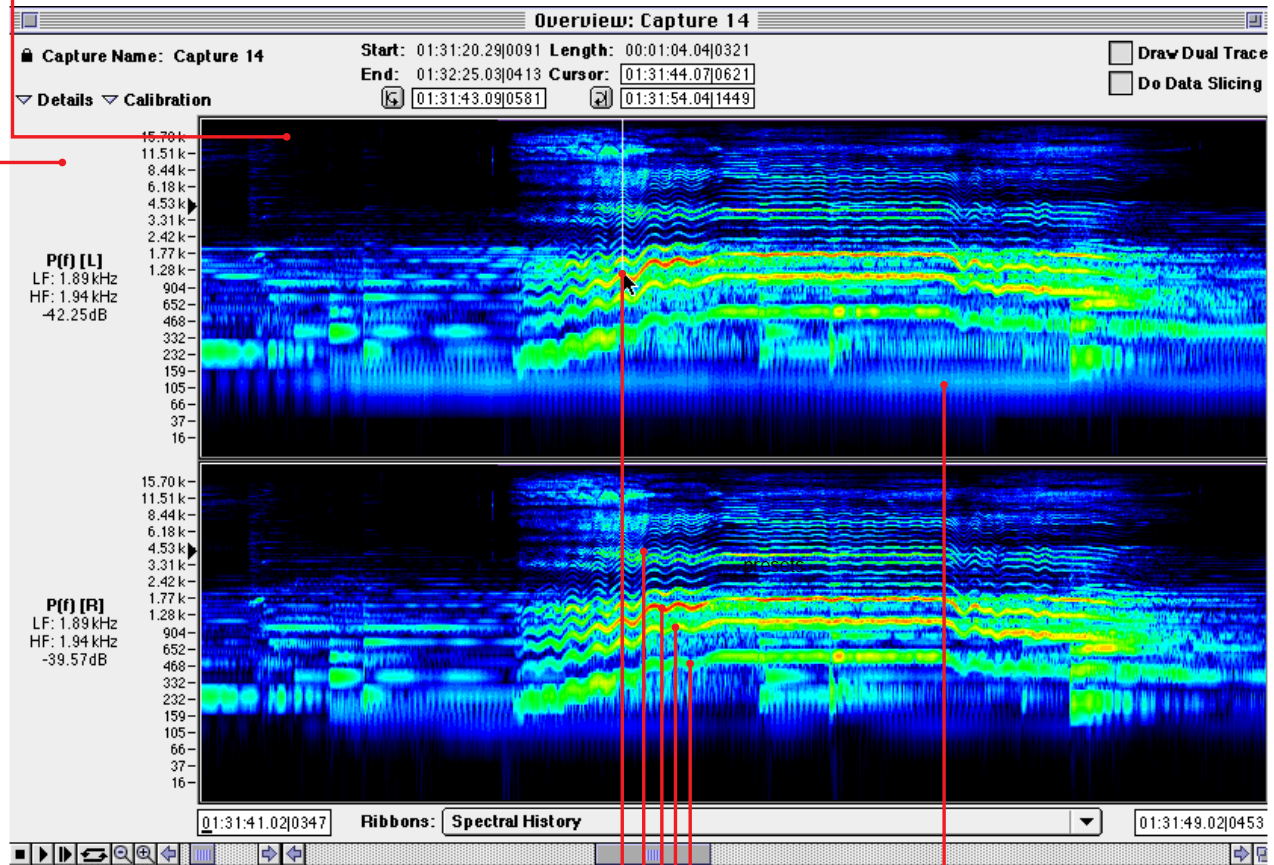
The screenshot displays the SpectraFootDM software interface with several callout boxes providing detailed instructions for various features:

- Top Left:** Click on this lock to activate the text field that allows you to name the capture.
- Top Center:** Click on these disclosure arrows to show/hide the details and calibrations for the overview window ribbons. The details provide precise numerical readings of the values of each display at the point of the capture which lies underneath the cursor.
- Top Right:** These buttons set the start and end times of a loop. When you click one of the buttons, the timecode value of the current cursor position will be copied into the corresponding timecode field. Click in the appropriate field to edit loop start and end points from the keyboard. You can also use the mouse to edit loop points in realtime. This will be described in detail in the section on looping captures.
- Right Side (Top):** This indicates the length of the capture.
- Right Side (Middle):** Clicking this check box will cause the "slice" of data that lies underneath the cursor to be displayed by the realtime instruments. This will be described in more detail below.
- Right Side (Lower):** Clicking this check box will cause the envelope ribbon to display the left and right channels superimposed on top of each other.
- Right Side (Bottom):** The Envelope overview shows the amplitude envelope history of the captured waveform. This is a very common display for digital audio editing and can be a helpful point of reference. You can zoom in to display the capture on a sample by sample basis. When captures are played back, the cursor moves across the ribbons until it gets near the end of the window. At this point, the ribbons begin to scroll very smoothly creating the effect of animation. As a result, when you have the envelope overview zoomed in all the way and play the capture, the display can function as a nifty storage oscilloscope (most storage scopes are not capable of playback).
- Bottom Right (Top):** The Power Balance ribbon is an overview history of the left/right power balance meter in the realtime rack. Drag the cursor along the ribbon and the Details readout will track the amount that the power in one channel exceeds the other as a percentage of the sum of the total power in both channels.
- Bottom Right (Middle):** The Power History ribbon is an overview history of the PPM and RMS meters. The details readout will track the Peak and RMS levels for the part of the display which lies under the cursor.
- Bottom Right (Bottom):** The Spectral History ribbon is an overview history of the Spectrogram from the realtime rack. This display is incredibly effective at revealing minute details of musical and sonic structure. When you hold down the option key and click the mouse in the ribbon, a marker will appear to the right of the frequency calibration giving a rough indication of the frequency of the spectral feature you are pointing at with the mouse pointer. The details readout will track the precise frequency range of the display feature you are pointing at. This will be described in more detail in the next illustration.
- Bottom Left (Top):** Clicking this button causes the capture to play from the beginning.
- Bottom Left (Middle):** Clicking this button causes the capture to start playing from wherever the cursor is in the ribbon.
- Bottom Left (Bottom):** Click this button to stop playback.
- Bottom Center:** This is a pop up menu which allows you to select which ribbons will be displayed in the Capture Overview Window. Selecting an item in the ribbons popup menu toggles it on and off. If you hold down the option key and select a ribbon, all other ribbons will be hidden. This allows you to utilize the entire Capture Overview Window to view a particular ribbon. This is illustrated in the next picture.

An Overview of the Overview

This is the spectral display of a highly dynamic and melismatic vocal passage. The music that this passage is taken from is part of the North Indian classical tradition. This particular piece is performed by female voice accompanied by sarode drone.

The relative power of overtones to the fundamental along with the initial transients of a sound determine its timbre. The Spectral History ribbon is very good at clearly displaying all of these characteristics. As a result, the spectral history is extremely effective in precisely identifying the features which differentiate a truly superlative timbre from a mediocre one.



Option clicking on the zoom buttons increases or decreases the number of data points used to compute the FFT for the Spectral History ribbon.

Option clicking on a spectral feature causes the details readout to display the precise frequency range that the selected feature occupies.

This area represents the sarode drone accompaniment.

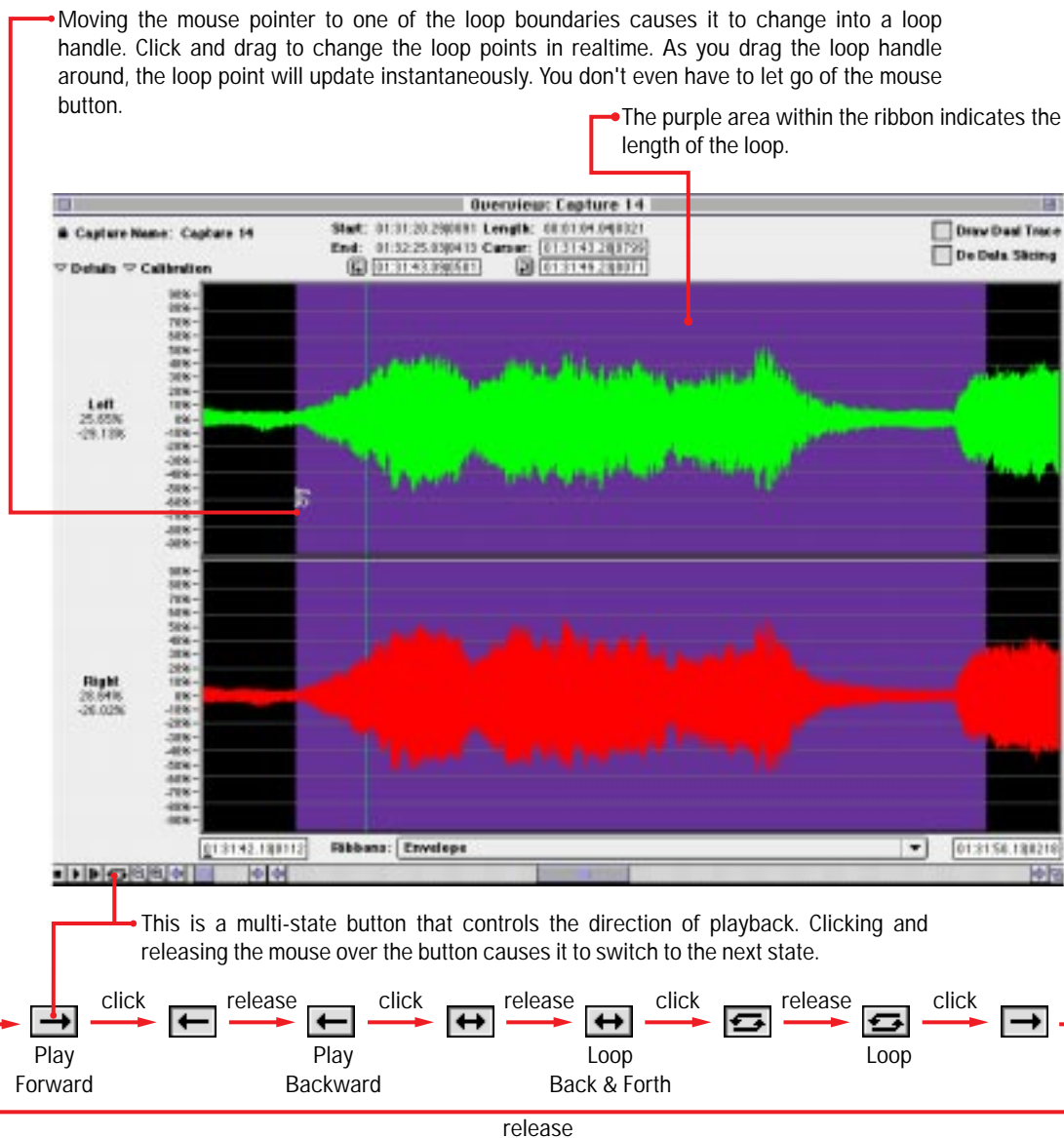
This is the fundamental of the female voice.

This is the second harmonic.

This is the third harmonic. Note that there is more power in this overtone than there is in the fundamental or any other harmonic. This is an explosive tension building passage. The timbral effect created by the strong third harmonic in the voice reinforces the musical gesture.

These are the upper overtones of the voice.

Analyzing Musical Structure with the Spectral History Ribbon



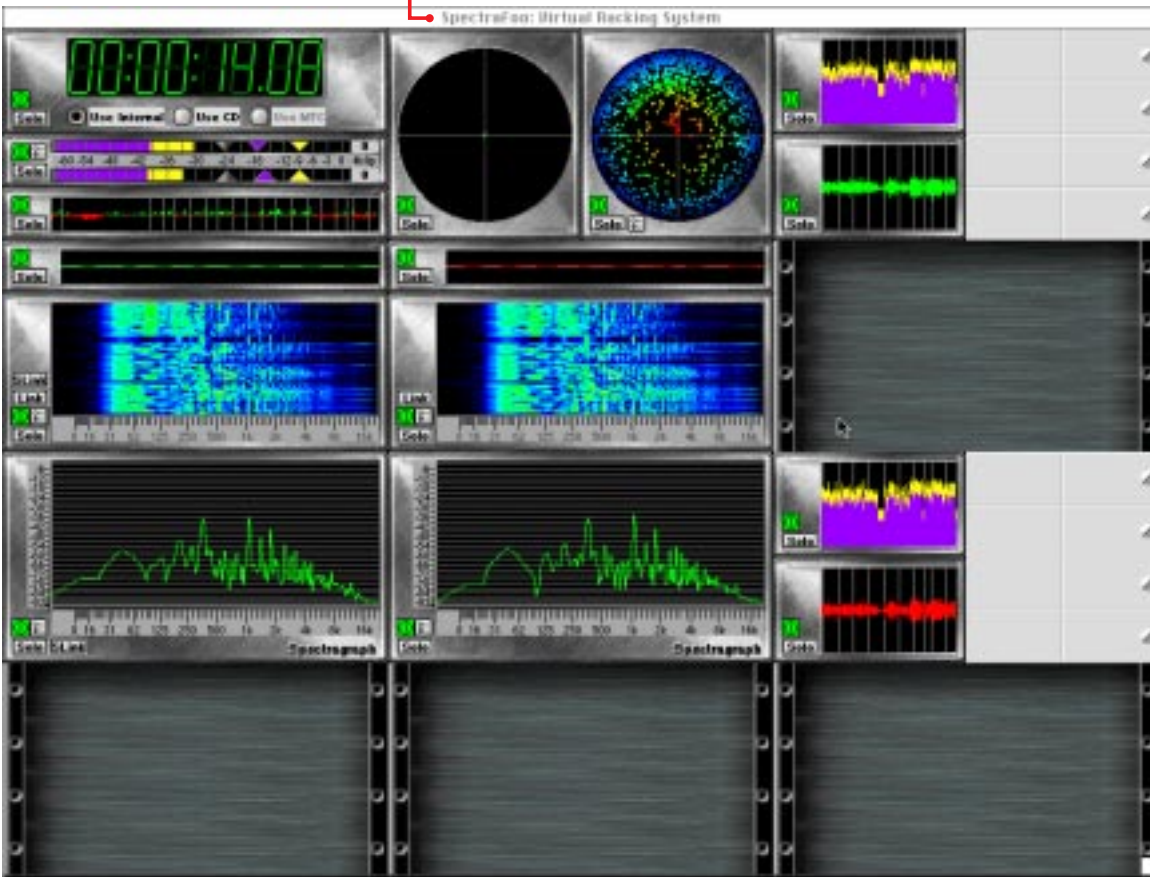
Creating playback loops in an Overview Window

In addition to analyzing captured signals, you can replay the captured signal throughout one of the system's audio-out paths (e.g. the built-in line out, or the digital out of a high-quality third-party audio card that will be supported soon). During replay, you may loop the signal and also analyze it. Looping and other playback functions are accessed by clicking on a multi-state button (see illustration above). One way that you may find this to be useful is in working on getting a mix sound for short-lived passages like tom-tom fills. By re-patching SpectraFoo's output into the appropriate input channels on your mixing console, you can work on compression, equalization, reverb, etc. while looping the source signal, all with an instantaneous return to the beginning of your loop and without any "wear and tear" on your multitrack master tape or your deck's transport.



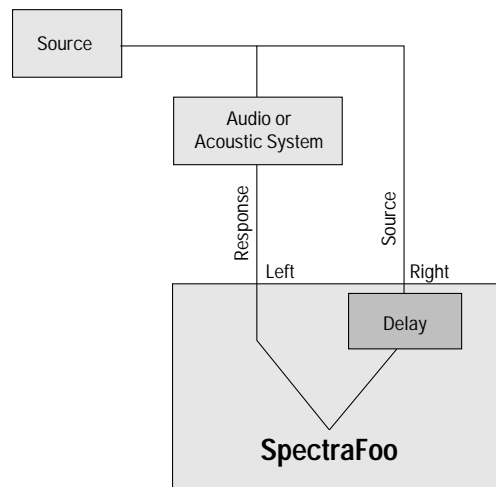
Click this checkbox to turn on Data Slicing.

When Data Slicing is enabled, the realtime instruments display the data which lies underneath the current position of the cursor. The grey area around the cursor represents the range of samples currently displayed by the realtime instruments. If you drag the cursor around in the overview window, the realtime instruments will continuously update to reflect the current cursor position. If you replay the capture, the realtime rack will continuously update in sync with the playback.



The Transfer Function

For live sound, equipment testing, or any application where you need to analyze the characteristics of acoustical and electrical audio systems, SpectraFoo provides Music Based Measurement (MBM™). SpectraFoo uses a transfer function display to show you the relative power and phase response between the left and right channels. The transfer function display assumes that the signal connected to the computer's right input is a source signal and the signal connected to the left input is a response signal.



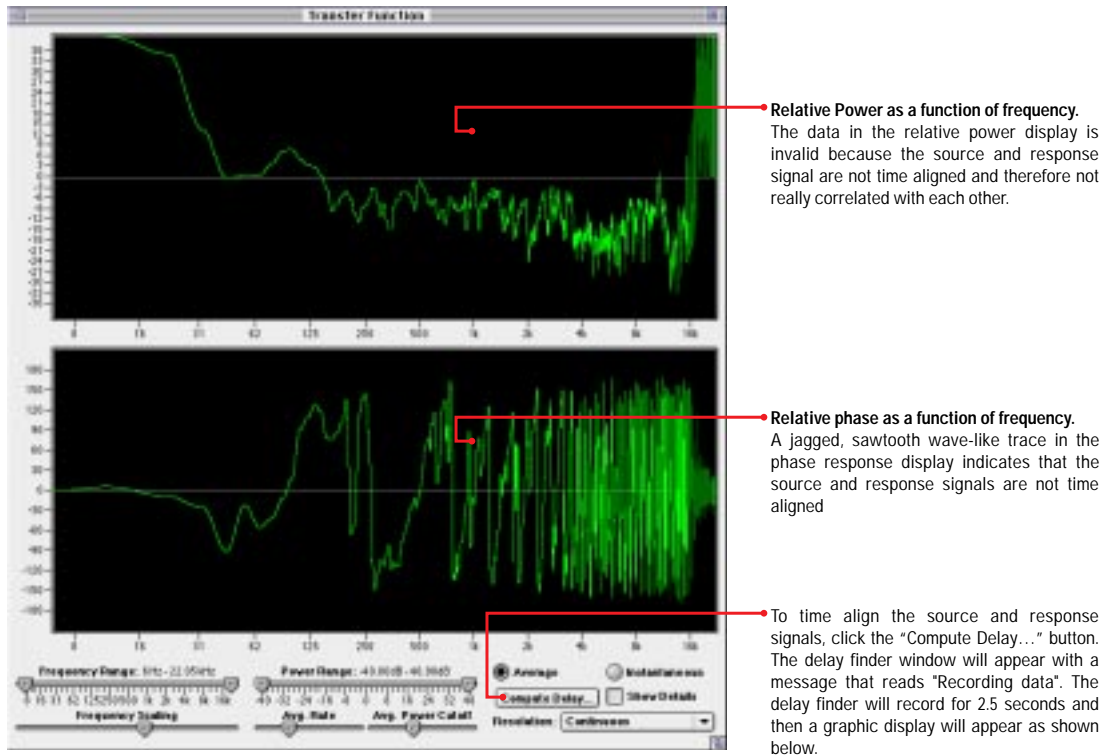
SpectraFoo Signal Arrangement for MBM Transfer Function

When the source signal is the input to some audio processing arrangement and the response signal is the measured output of the system, you can use music as your “test tone”. SpectraFoo uses the source signal as a point of reference and the transfer function display shows the differences in amplitude and phase between the source and response as function of frequency. This allows you to measure the properties of audio processing systems, including systems that contain acoustic elements. You can determine the amplitude and phase response of an equalizer in the presence of musical signal as easily as measuring the sound coloration of an acoustic space.

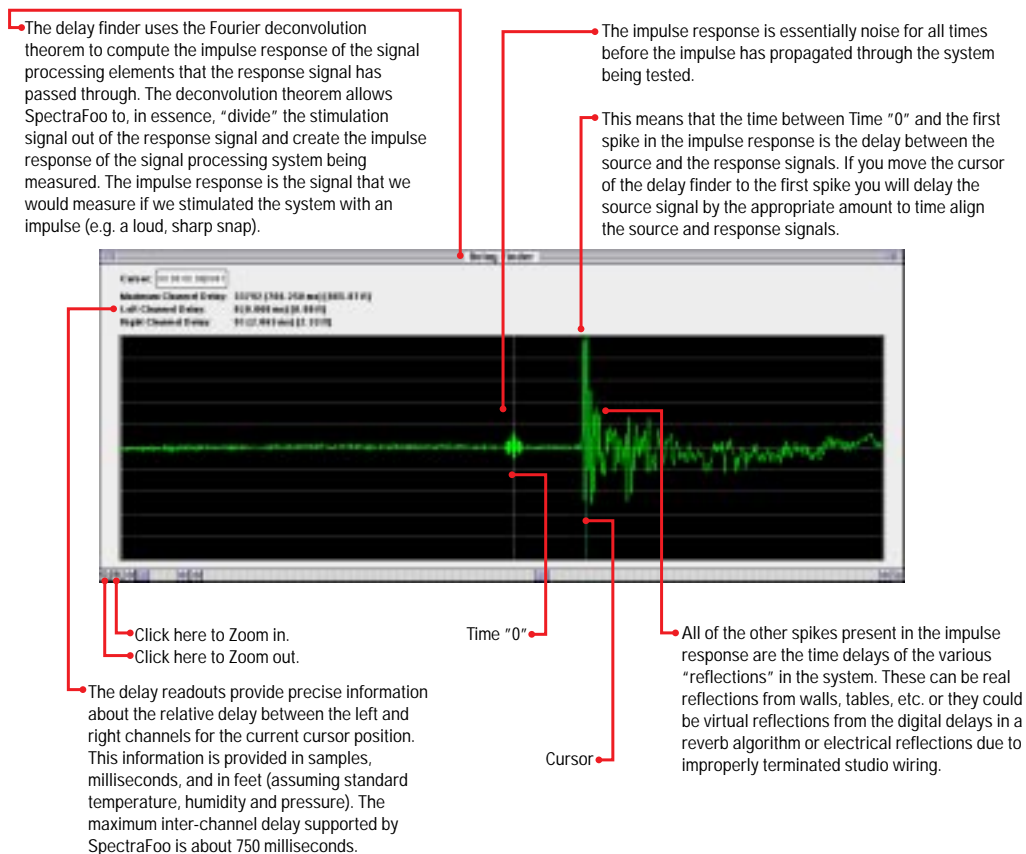
The transfer function really only makes sense when the source signal is the input to some audio processing arrangement and the response signal is the measured output of the system. It does not generally make sense if the source and response are truly unrelated, as in the case of the two channels of a stereo mix (in this case meaning a multi-track mix, with panned elements, as opposed to a true stereo program, such as an X–Y recording).

Even in the case of a stereo mix, the transfer function may provide some information about the spectral balance of the recording, but, in general, the spectral balance is not constant in time.

Even when the source and response signals are related, they usually will not be time-aligned. For example, if you are measuring the room response of an auditorium, there will be the speed-of-sound acoustic delay between the source signal and the response signal received at the measurement microphone. In order to properly measure the power and phase of the response signal relative to the source signal, the source signal must be delayed to time-align it with the response signal. SpectraFoo provides a delay detection feature that is accessed via the “Compute Delay...” button present in the Transfer Function window. The delay finder records a segment of both signals and computes the correlation of the signals with each other. By moving the cursor to the largest correlation of the two signals, you set the system delay and compensate for the measurement delay, time-aligning the two signals. Now the transfer function measurements will be accurate.



Transfer Function of a Room Response with a time delay



Time Aligning the measurement with the Delay Finder Windows

This graph shows the relative phase of the source and response signals as a function of frequency. A trace oriented on the zero line indicates that the signals are in phase. For frequencies where the trace is above zero, the source is delayed from the response by the indicated number of degrees. For frequencies where the trace is below zero, the response is delayed from the source by the indicated number of degrees.

This graph shows the amplitude difference between the source and response signals as a function of frequency. A trace oriented on the zero line indicates that the source and response signals are the same. For the frequencies where the trace is above zero, the response signal has more power than the source. For the frequencies where the trace is below zero, the response has less power than the source.

Use these sliders to set the frequency and power ranges used by the display. The sliders work in exactly the same way as those found in the Details windows for the Spectragraph and Spectrogram.

This slider allows you to set the frequency scaling of the display. When the slider is all the way to the left, the scaling is roughly linear. When the slider is all the way to the right, the scaling is logarithmic.

The Average Rate Slider allows you to adjust the time constant of the averaging process. When the slider is to the far left, the average value tracks the instantaneous measurements quite closely. As the slider is moved to the right, the average is computed from longer and longer periods of the instantaneous signal.

The Average Power Cutoff Slider allows you to adjust the minimum amount of signal that needs to be present in each frequency band of the source signal before the current measurement is included in the average for the frequency band. This is the key to MBM. Adjust this parameter to trade off between noise rejection and range of frequencies for which average information will be computed. Choosing wideband source material gives you the best S/N vs. bandwidth tradeoff.

Compute Delay calculates the delay between the left and right channels and opens a Delay Finder Window to let you compensate for the delay.

Transfer Function after the measurement has been time-aligned

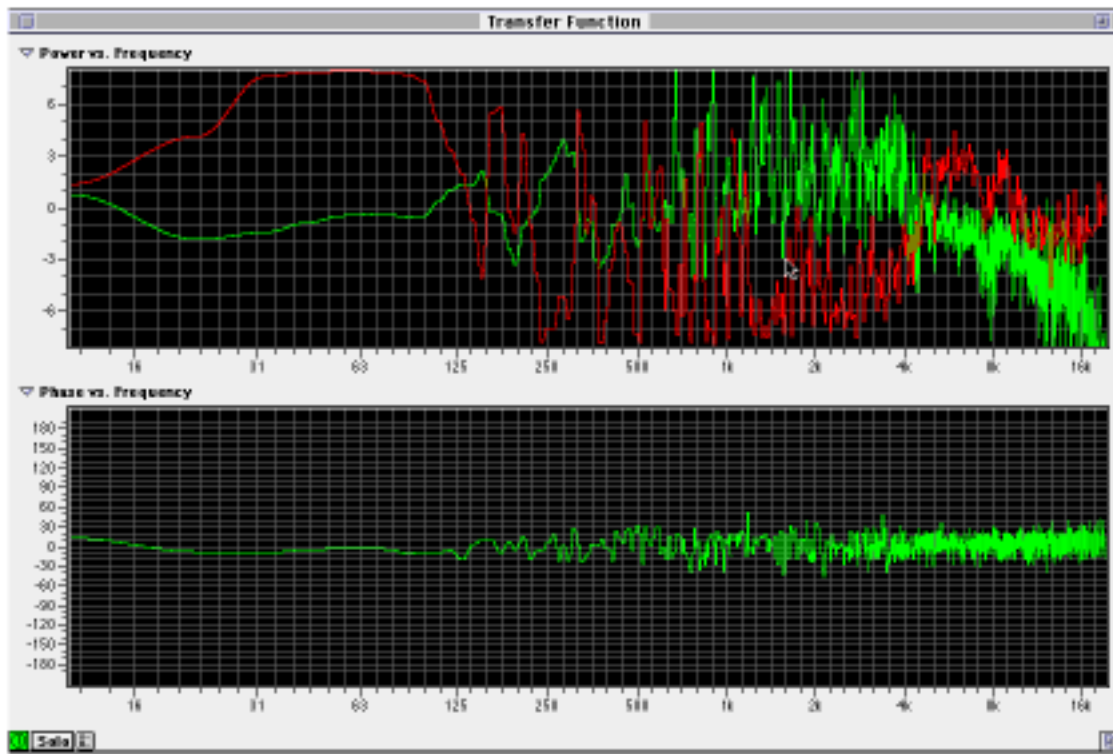
The Transfer Function's New Look: v1.5

The parameter controls for the Transfer Function have been moved out of the Transfer Function window and placed in a details window. This is consistent with the operation of all other SpectraFoo instruments. The Transfer Function details window is accessed by clicking on the show details button in the Transfer Function window or in the Master Controls window. In addition, the Transfer Function now has a solo button and an on/off button.

Coherence

The Transfer Function window now has a Coherence trace. Coherence is displayed as a red trace in the power vs. frequency display. Coherence has a value of 0 when the trace is at the bottom of the display and has a value of 1 when the trace is at the top of the display and varies linearly in between.

Coherence is a measure of how well the response signal correlates with the source signal. When Coherence is at its maximum value of 1 for a given frequency band, the source and response are perfectly correlated and the Transfer Function is completely uncontaminated by noise. When Coherence is at its minimum value of 0 for a given frequency band, there is no correlation between the source and response and the measurement in this frequency band is invalid. Coherence can be used as a guide to determine which frequency bands are equalizable. Frequency bands for which Coherence is low cannot be corrected by equalization. Frequency bands for which Coherence is high are equalizable.



The Updated Transfer Function Window

Epilogue

Welcome to the end of the tour. By this point, you should have a good understanding of the basic features and capabilities of SpectraFoo. More Application Notes are coming soon (check the website for applications updates <http://www.mhllabs.com>). It should be clear by now that SpectraFoo was designed with a strong musical bias. It has profound implications for creative work in such diverse areas as Mastering, Recording and Mixing, Audio/Video Post-production, Music Synthesis Research, Sound Design, Musical Instrument Design, Loudspeaker Testing, and Ethnomusicology, among others.

Although SpectraFoo was designed for the professional engineer, it is also an excellent educational tool. By giving students quantitative feedback that is synchronized with what they hear, SpectraFoo helps to accelerate the development of critical listening skills. Using SpectraFoo, it is possible to make measurements of subtle sonic effects while you are experiencing them. This *quickly* leads to a deep understanding of how to achieve a sound and how to fix problems when they occur.

While we have touched on a number of possible applications, we expect that you will think of many others. In fact, like the makers of any good tool, we expect to be amazed and astounded by some of the things that you accomplish with SpectraFoo.

In its current implementation, SpectraFoo is not intended to be a replacement for specialized audio component test equipment such as Audio-Precision. However, using SpectraFoo in conjunction with such equipment will increase the scope of the analysis which can be performed on audio systems. SpectraFoo can be used to make dynamic electrical engineering measurements which are difficult or impossible to make with other analyzers due to their inherent speed limitations. An example of such a measurement is: Measuring the distortion characteristics introduced by the manipulation of dynamic analog circuit elements such as potentiometers or by the manipulation of the parameters of a DSP algorithm (eg. moving a fader on a digital console).

SpectraFoo's greatest strength lies in its ability to provide quantitative measurements which can be synchronously referenced against the subjective experience. This is the "Foo factor". It is a widely held belief in audio circles that good specs and performance "on the bench" do not necessarily guarantee exceptional sound quality. It is our belief that this discrepancy is due, in large part, to the dynamical behavior of electronic systems. Until now it has been impossible to test systems with signals that properly stimulate this dynamical behavior. The heretofore available test equipment simply was not fast enough to analyze and display measurements that provide any meaningful information about the dynamical behavior of audio devices in the presence of real musical signals. SpectraFoo provides the technology that makes dynamical testing possible.

We hope that you will get as much enjoyment and insight from working with SpectraFoo as we have gotten from developing it.

Developer's Note: Please feel free to stress SpectraFoo as much as possible. Our primary design objectives have been to create a system that is not only extremely fast and easy to use, but also stable and robust. We believe that software should not surprise you, shouldn't break, and should never, ever crash the computer it is running on. If you encounter *any* stability problems with SpectraFoo, please contact us immediately.

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