Triton User Guide

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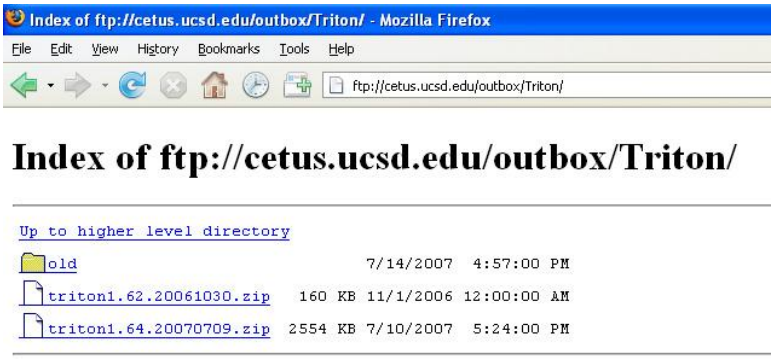
Quick Setup

Software Required

The Triton software package was developed using MATLAB, a hi-level programming language. MATLAB (www.mathworks.com) must be installed on the current computer for Triton to function. MATLAB is available for many operating systems including Windows, Mac and Linux. However, Triton was developed using Windows XP sp2 and MATLAB 7.0 (Release 14) and has not been extensively tested with other operating systems or versions/releases of MATLAB.

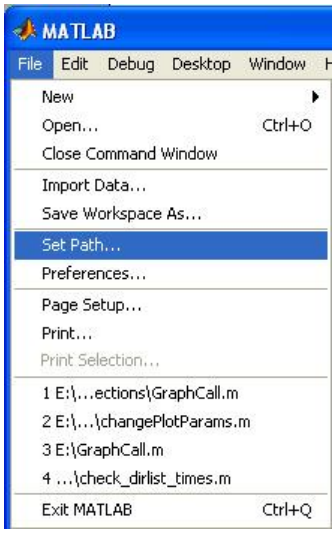
Install Triton

- To get the most recent release of Triton: Download the zip compressed file (eg. Triton1.64.20070709.zip) at ftp://cetus.ucsd.edu/outbox/Triton/

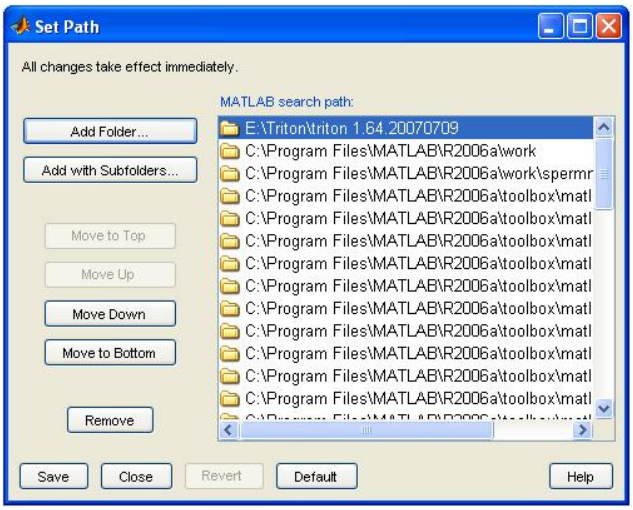


- Uncompress the zipped file in an empty folder or directory, such as D:\Triton

- Set MATLAB's path to include the directory where Triton was uncompressed by using the MATLAB File pull-down and 'Set Path…'



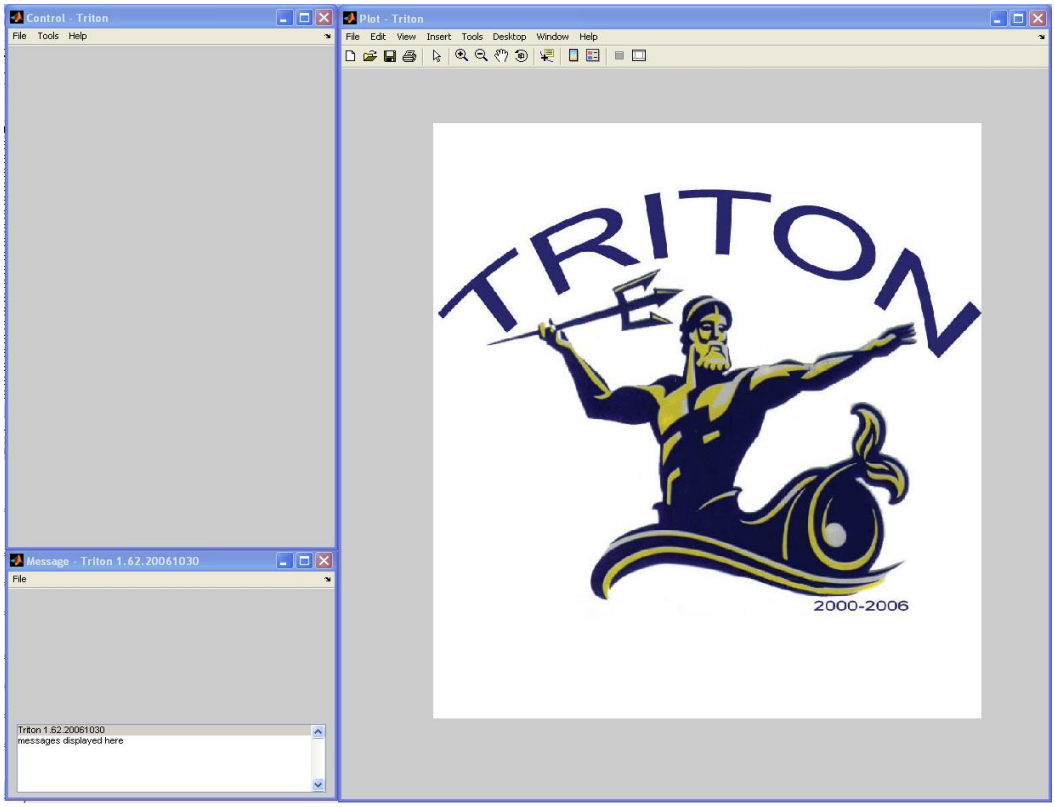
- Click the ‘Add Folder…’ button, browse and select the folder containing the version of Triton that you want to run, Remove other versions of Triton from the path with the ‘Remove’ button. Click ‘Save’ and then ‘Close’.



Start Triton

- Start Matlab and at the command prompt (>>) type “triton” to run the application.

- Three windows will be displayed: Plot, Control, and Message.



Plot Window (Right) - Displays Long Term Spectral Average (LTSA), spectrogram, spectra and time series plots.

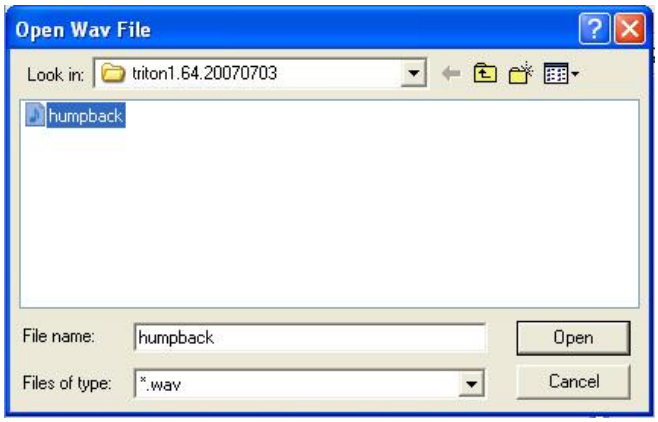
Message Window (Lower Left) - Keeps a record of the users actions and displays Plot Window cursor location along with ‘pick’ data.

Control Window (Upper Left) – Control settings for Plot Window.

Load and View an Example Sound File

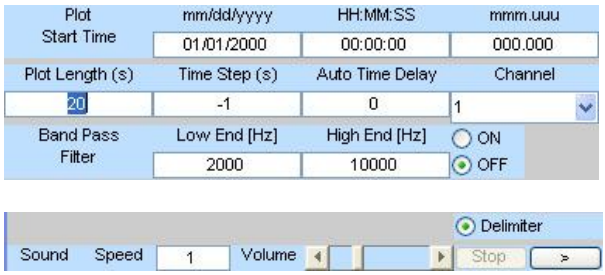
Use the Control Window File pull-down menu to open a WAV file.

In the Triton software directory, select humpback.wav and click Open.



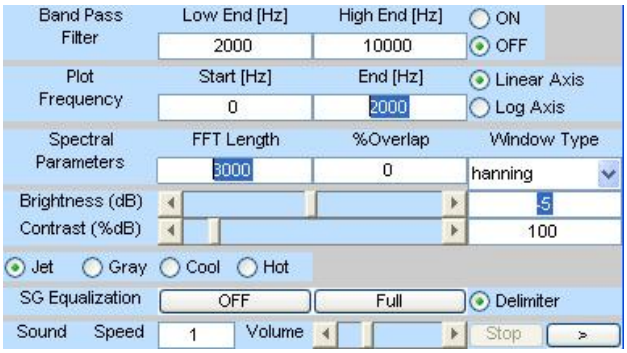
Click OK or set the start time of the WAV file. The WAV file will then be opened up as a time series in the Plot Window.

The plot settings can be changed within the blue section in the Control Window. Set the Plot Length to 20 seconds to view the whole file.



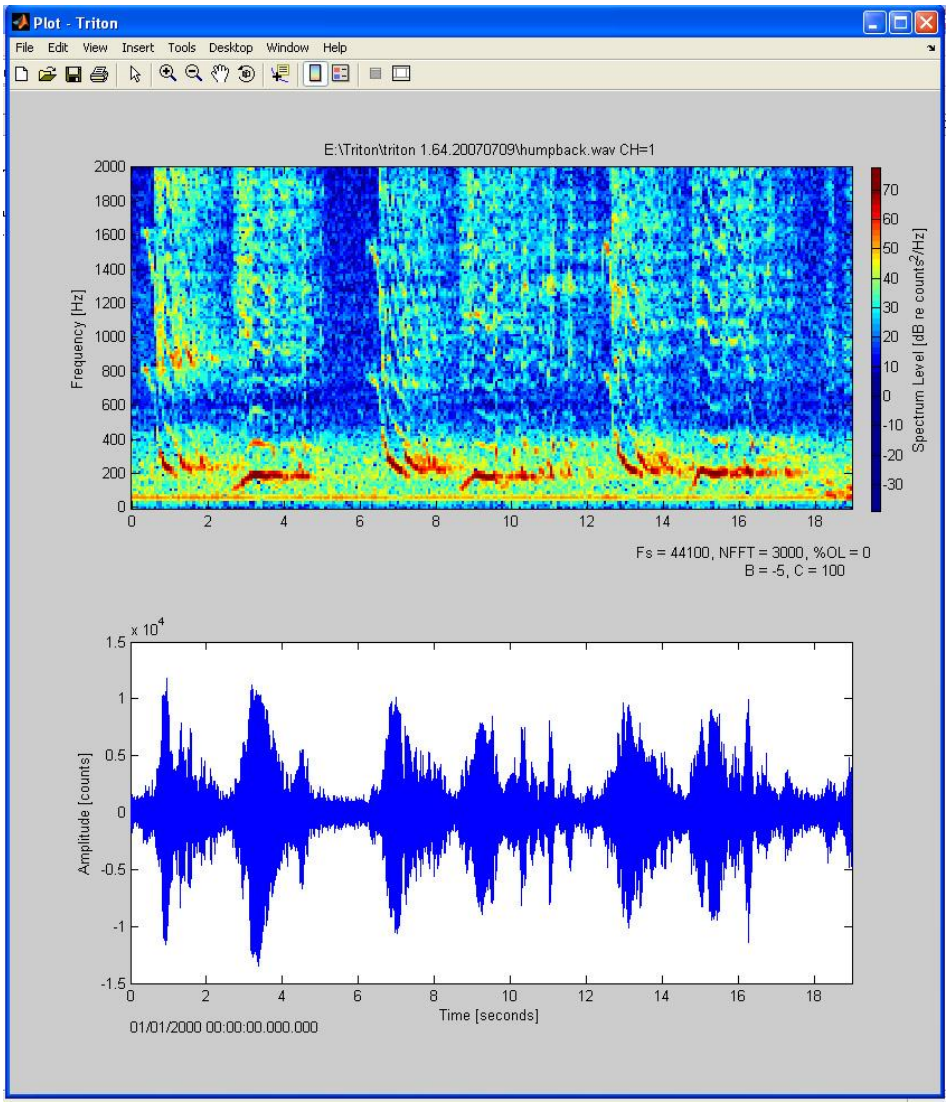
Select the Spectrogram button at the top of the Control Window to display the WAV file data also as a time-frequency plot.

Adjust some of the spectrogram plot parameters and listen to the WAV file sound.



- Set Plot Frequency End to 2000
- Set FFT Length to 3000
- Set Brightness to -5
- If your computer has sound playing capabilities, play the sound by pressing the > button at the bottom right of the Control Window.

Based on above changes, the Plot Window should look like the following:



Triton Overview

Summary

There were two primary goals with the development of Triton. The first was to provide a tool which can be used to evaluate acoustic data recorded by Acoustic Recording Packages (ARPs)[1], and more recently High-frequency Recording Packages (HARPs) [2]. These data are typically single channel, long duration (up to one year), continuous and scheduled duty-cycle time series. The time series data are often transformed to the spectral domain for evaluation as power spectra, spectrograms and Long Term Spectral Averages (LTSA). Triton provides the necessary tools to quickly review a large data set via an easy to use graphical user interface (GUI).

The Second goal behind the development of Triton was to provide a basis for additional features and enhancements. For example, event detection and classification algorithms are currently being developed for use with Triton, utilizing Triton's data management tools and GUI.

File Types

- Data from ARPs & HARPs, are formatted into XWAV files. XWAV files are similar to WAV files, but also contain additional header information such as instrument location, depth, name and most importantly, time and date (see Appendix A1 + A2).
- Triton can read standard WAV files including multichannel WAV files (but it can only display one channel at a time). WAV files are typically acoustic time series and include recording parameters like sample rate and bytes per sample.
- Triton also works with Long-Term Spectral Average (LTSA) files. LTSA files are generated from a collection of WAV or XWAV files by averaging spectra over a long time periods and arranging these spectra sequentially as frequency-time spectrogram plots. In addition to providing a quick overview of long-term recordings (for example, hours to weeks can be displayed on a single plot, depending on sample rate), LTSA's provide a quick and easy link to the finer-scale acoustic data of WAV or XWAV files by simply clicking an event of interest in the LTSA plot (see following LTSA section).

Features

Triton can:

- Read raw HARP disks, evaluate data timing and make XWAV files
- Generate time series, spectrogram, and spectra plots from WAV and XWAV data files
- Create Long Term Spectral Average (LTSA) files from WAV or XWAV files and plot LTSA's
- Save individual plots as WAV, XWAV, jpg, or other graphical file types
- Convert ARP *.bin, OBS, and Raw HARP data files to XWAV format
- Decimate high sample rate data files to smaller & lower sample rate XWAVs. For example, for baleen whale call analysis.

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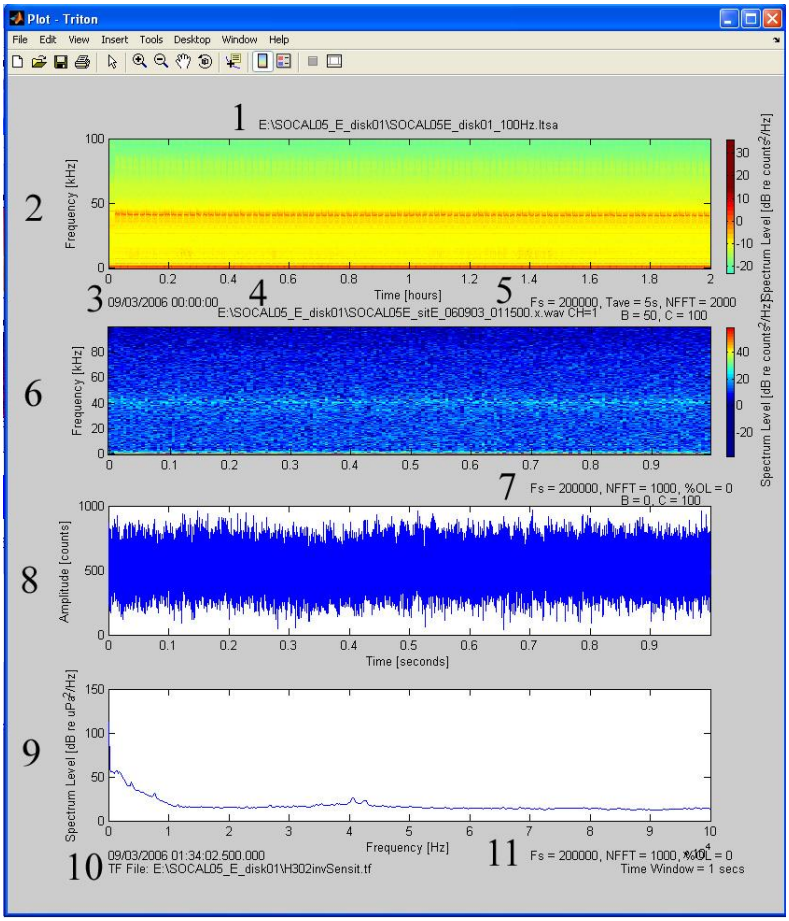
[1] Wiggins, S. M., Autonomous acoustic recording packages (ARP's) for long-term monitoring of whale sounds, Marine Technology Society Journal, vol. 37(2), pp. 13-22, 2003.

[2] Wiggins, S. M. and Hildebrand, J. A., High-frequency Acoustic Recording Package (HARP) for broad-band, long-term marine mammal monitoring. International Symposium on Underwater Technology 2007 and International Workshop on Scientific Use of Submarine Cables & Related Technologies 2007, Tokyo, Japan, Institute of Electrical and Electronics Engineers, pp. 551-557, 17-20 April, 2007.

Triton Windows

Plot Window

The Triton Plot Window is a standard MATLAB figure window, allowing it to be modified, saved in various formats, and printed. All pull-downs and tools are the same as typical MATLAB figure windows except the zoom in/out tools which will modify the Plot Start Time after zooming in and deselecting the tool.

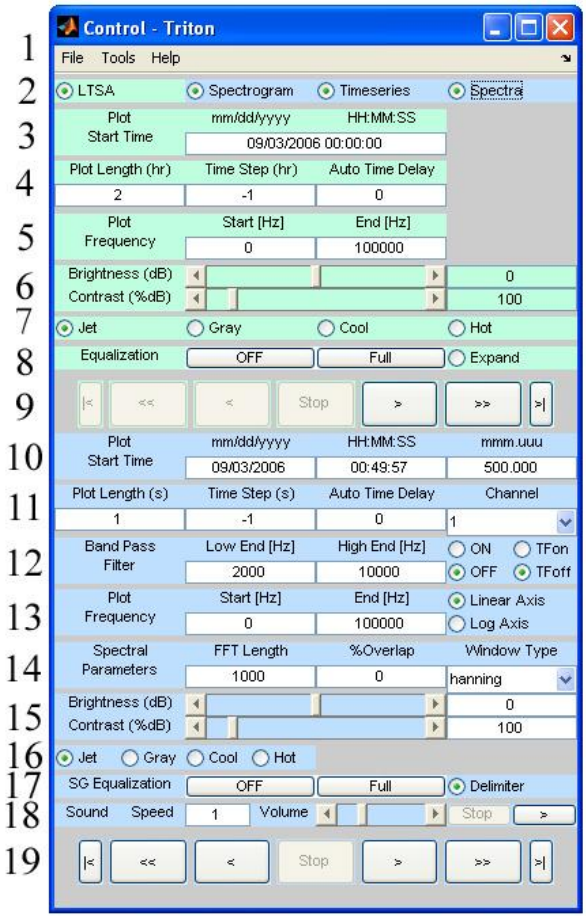


Components of the Plot Window:

1) LTSA file name
2) LTSA plot
3) LTSA Plot Start Time
4) XWAV/WAV file name
5) Parameters used to generate and plot LTSA
6) Spectrogram plot
7) Parameters used to generate and plot spectrogram
8) Time series plot
9) Spectra plot
10) XWAV/WAV Plot Start Time
11) Parameters used to generate and plot spectra

Control Window

The Control Window allows users to open, convert, and plot data files in addition to controlling various plotting parameters. The Control Window has three main sections: pull-down menus, light green LTSA plot control, and the Light Blue XWAV/WAV plot control.



LTSA Plot Control – Light Green

1) **File**, **Tools**, and **Help** pull-down menus – see next section.
2) Toggle on/off the different plot types: **LTSA**, **Spectrogram**, **Timeseries**, and **Spectra**. Note the Control Window color scheme: LTSA plot control is light green, and the XWAV/WAV plot controls are light blue.
3) **Plot Start Time** – Display and change LTSA plot start time.
4) **Plot Length (hr)** – LTSA plot display length
   Time Step (hr) – LTSA plot step size between the start of plot frames. Set to -1 for steps equal to one Plot Length frame of data. Set to -2 for steps in real time equal to Plot Length.
   Auto Time Delay – Time delay in seconds between plot frames during auto forward and auto rewind (see below)
5) **Plot Frequency** – LTSA plot start and end frequencies

6) **Brightness** and **Contrast** adjustments for LTSA plot. Adjustments can be made with the sliders, arrows, or by entering values.
7) Select LTSA plot color map
8) **Equalization** – Toggle on/off removal of average LTSA levels. Toggle between full plot frame average or shorter user picked window to be subtracted from LTSA leads.
Expand – Activates cross hairs to pick an event in the LTSA plot and open the data originating XWAV/WAV file at the corresponding time (see LTSA selection).
9) LTSA plot frame step buttons:


Go to start


Go to end


Rewind one step


Forward one step


Auto rewind


Auto forward


Stop auto forward/rewind

XWAV/WAV Plot Control – Light Blue

10) **Plot Start Time -** Display and change XWAV/WAV plot start time.
11) **Plot Length (s)** – XWAV/WAV plot display length
Time Step (s) – XWAV/WAV plot step size between the start of plot frames. Set to -1 for steps equal to one Plot Length frame of data.
Auto Time Delay – Time delay in seconds between plot frames during auto forward and auto rewind (see below)
Channel – Select which WAV file channel to display
12) **Band Pass Filter** – **Low** and **High** corner frequencies for band passing the display XWAV/WAV data. Toggle **On/Off** transfer function correction for Spectra plot only (See transfer function section). Need to load transfer function from Control Window 'File' pull-down menu (see next section).
13) **Plot Frequency** – XWAV/WAV plot start and end frequencies.
14) **FFT length** – Length of Fast Fourier Transform (FFT) window in samples
%Overlap – Percent of Window overlap
Window Type – Hanning is currently the only available window type.
15) **Brightness** and **Contrast** adjustments for LTSA plot. Adjustments can be made with the sliders, arrows, or by entering values.
16) Select WAV/XWAV plot color map
17) **SG Equalization** – Toggle On/Off removal of average XWAV/WAV levels. Toggle between full plot frame average or shorter user picked window to be subtracted from XWAV/WAV leads
Delimiter – Toggle on/off a vertical line depicting the break between sequential HARP raw files in XWAV data.
18) **Sound** – Speed of sound playback 0.1 to 10 times normal. Volume of sound play back play sound  through computer sound system. Stop sound play back.
19) LTSA plot frame step buttons:


Go to start


Go to end


Rewind one step


Forward one step

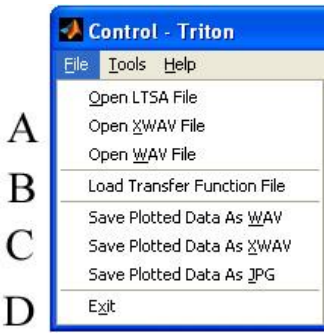

Auto rewind


Auto forward


Stop auto forward/rewind

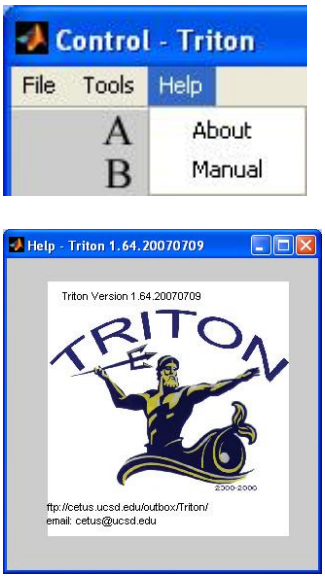
Control Window Pull-Down Menus

File Pull-Down Menu



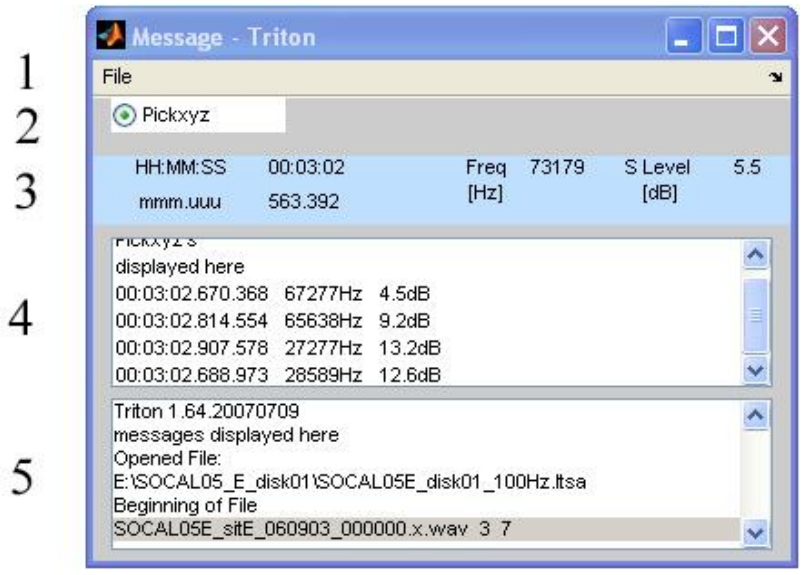
A) **Open LTSA**, **XWAV** or **WAV** files.
B) **Load Transfer Function files** - See Transfer Function Files section
C) **Save** – Plotted data as **WAV**, **XWAV** or **JPG** files
D) **Exit**- Exit Triton

Help Pull-Down Menu



A) Select **About** to display Triton help pop up window which provides your current Triton version number, the ftp site for past and current versions of Triton, and an email address to report bugs or request support/enhancements.
B) Select **Manual** to open this Triton user manual with adobe acrobat (www.adobe.com)

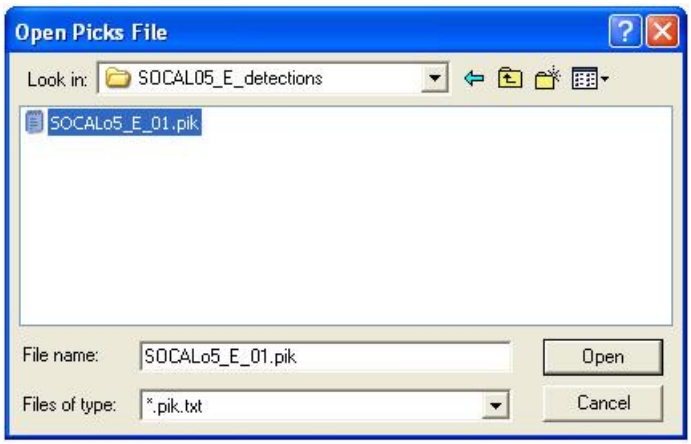
Message Window



1) **File** pull-down menu – see next section.
2) Toggle on/off the **Pickxyz** tool in the Plot Window. When cursor cross-hairs are activated with toggle on, left button mouse clicks in Plot Window are shown in Pickxyz display.
3) Displays the current information about the location of the cursor in the Plot Window. Activated by left button mouse click in Plot Window. Background color is based on what plot the cursor is in: light green for LTSA's, and light blue for spectrograms, spectra and time series.
4) **Pickxyz Display** - Pickxyz data is displayed in a scrollable display. Information can be deleted or added to this window including user defined notes. The information in this window can be saved to output files (*.pik) and previous saved *.pik files can be uploaded to the window for additional Pickxyz's and modifications.
5) **Message Display**- Information based on various operations including error and warning messages are shown to the user in scrollable display. Information in this display is not editable, but can be saved (*.msg) and used for session logging or software bug reporting.

Message Window Pull-Down Menus

A) **Open** - Open previously saved Pickxyz files (*.pik)



Save - Save current Pickxyz display data to a *.pik ascii text file

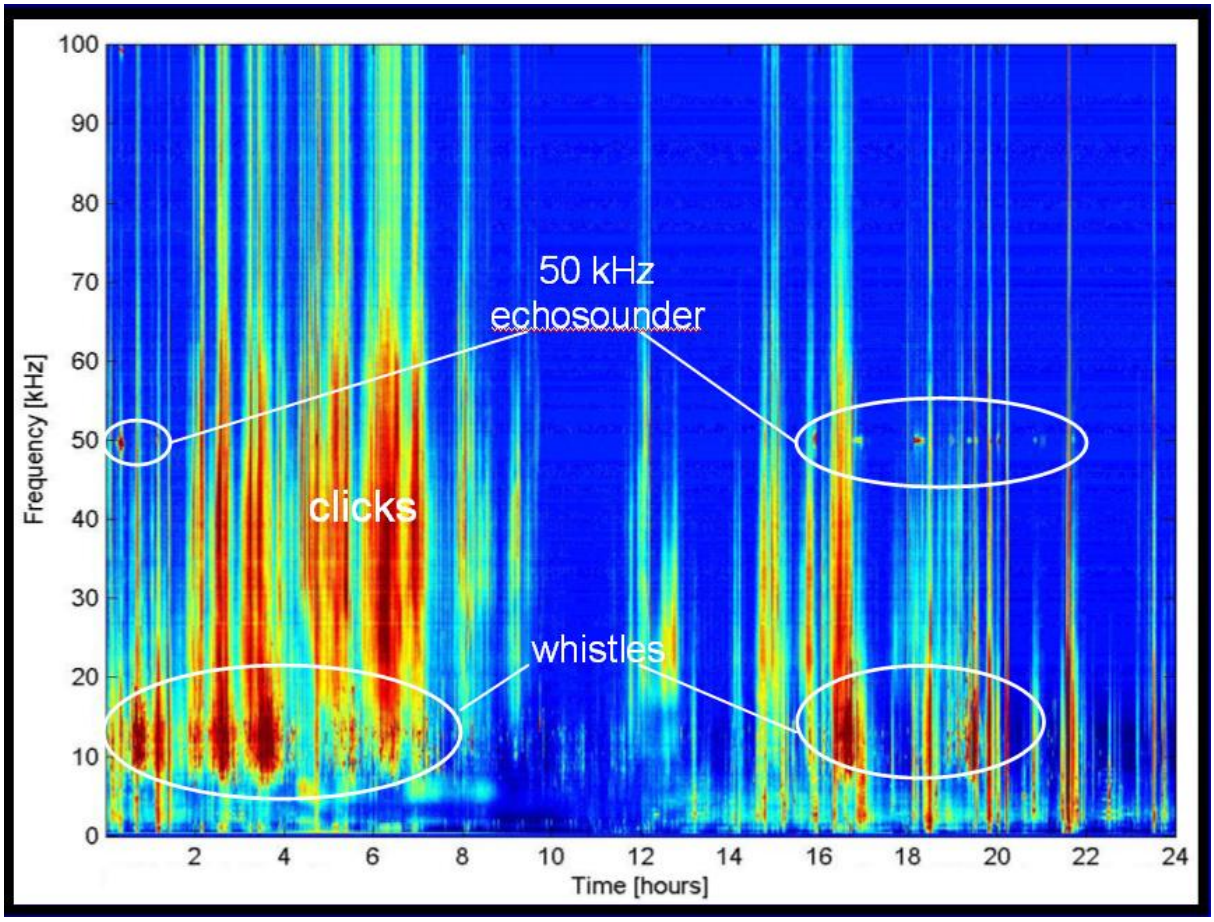
B) **Save** - Saves current Message display to a *.msg ascii text file
Clear - Clears the current Message display of all information

Long Term Spectral Avera (LTSA)

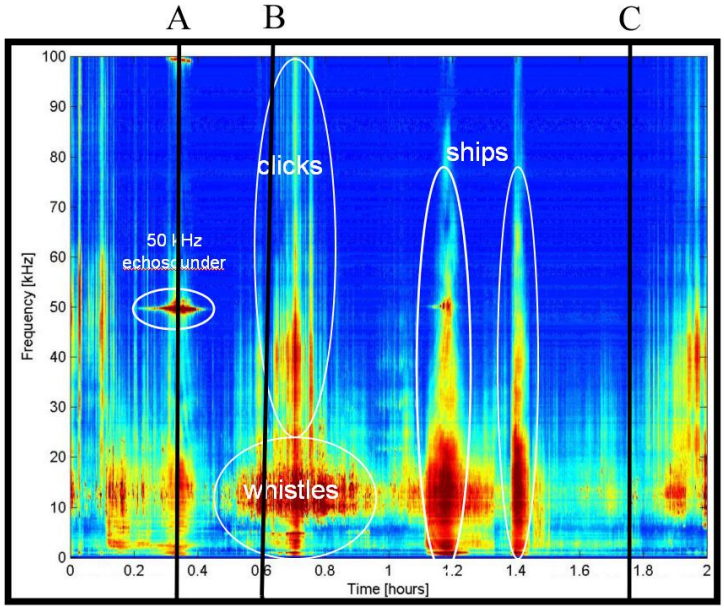
LTSA Overview

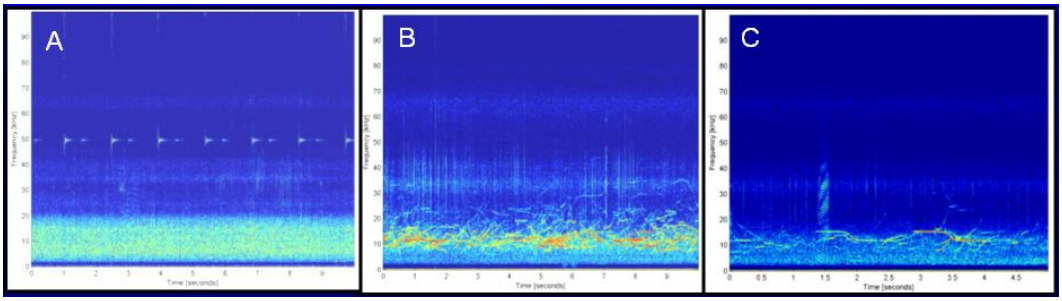
LTSA (Long-Term Spectral Average) plots allow large time series data sets to be viewed and analyzed including searching for and noting acoustically significant events, like whale calls. In 2006, each HARP (High-frequency Acoustic Recording Package) deployment was capable of producing about 2000 XWAV files (~ 2 TB total), but viewing and analyzing each one of these XWAV files is not practical. LTSA plots provide a means of presenting an overview of these large data sets in a compressed format and allow quick linking to noteworthy events in the finer time scale XWAV data, which originally were used to generate the LTSA plots.

An LTSA of time-series data is essentially a spectrogram (three dimensional time-frequency-energy plot) where each frequency spectrum plotted along time is averaged over a longer period than one windowed frame of a Fast-Fourier Transform (FFT). The quantization time of an LTSA is defined as the duration over which consecutive single-window spectrum are averaged. The averaged spectra are then plotted sequentially with energy shown as color.



Above is an example of a 24 hour LTSA from 35 GB of data sampled at 200 kHz off the shore of Southern California. Notice how well ship echosounders and dolphin clicks and whistles can be identified, and periods when the region is relatively quiet.



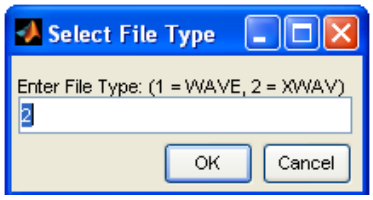


The LTSA plot above is from the first two hours of the previous figure, and the three plots A, B, and C are spectrograms from the XWAVs used to generate the LTSA at the corresponding times A, B, and V in the LTSA plot, notice the differences.

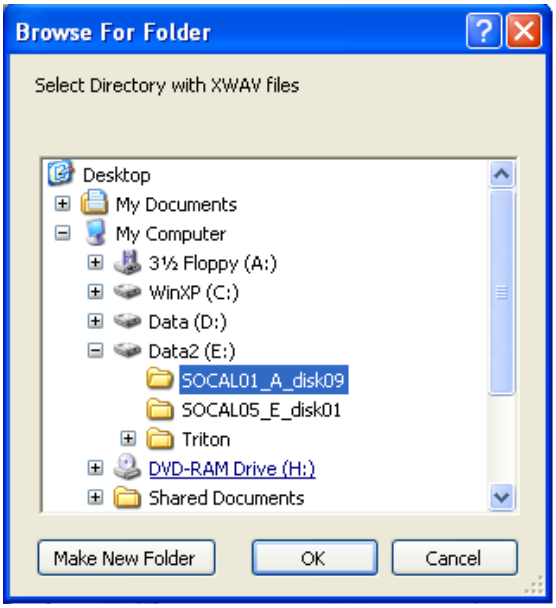
Creating LTSA Files

- Select "Make LTSA from Directory of Files" from Tools pull-down menu in Control Window.

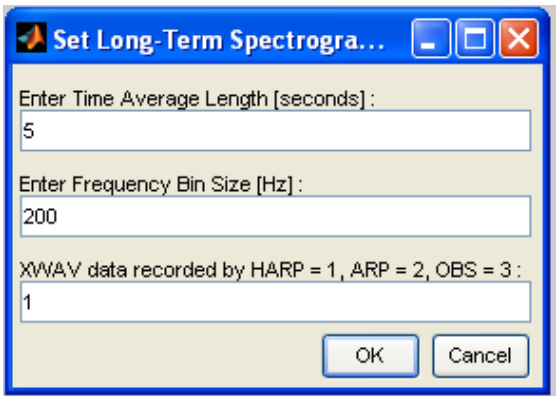
- Select file type, Type ‘1’ for WAV files or ‘2’ for XWAV files.



- Select directory where the WAV or XWAV files are located.



- Set Long-Term Spectrogram Parameters
  - **Time Average** – length of time to average in each frequency bin
  - **Frequency Bin Size**
  - Data source:
    - **1 = HARP**
    - **2 = ARP**
    - **3 = OBS**

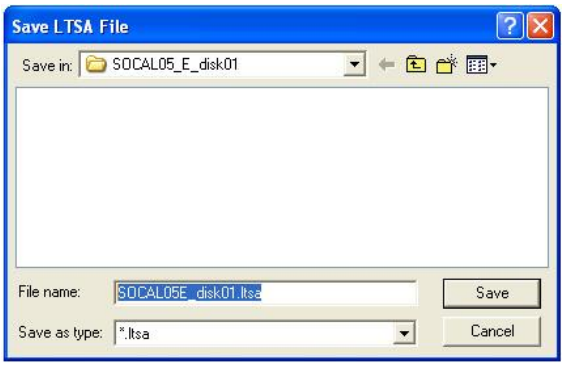


IMPORTANT

LTSA parameters are typically data sample rate dependent. The default parameters shown in the previous figure are for broad-band data, from a HARP sampling at 200 kHz. For lower sample rate ARP data (eg. 500 Hz or 1000 Hz), try the following or similar parameters:

- Time Average length 120 seconds
- Frequency Bin Size 1 Hz
- Data Source 2 (ARP)

- Enter file name of LTSA output file. The file name should have an *.ltsa extension.



- Click Save

- The amount of time required to create the LTSA depends upon the parameters selected, the type and quantity of data to be processed, and the speed of the computer. As an example, it requires approximately 4 hours to process 3 days of 200 kHz 16-bit data on a "mid-range" computer built in 2005.

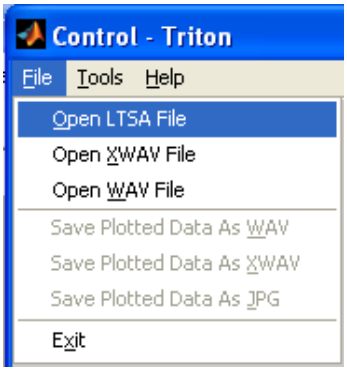
- MATLAB will be 'busy' until the LTSA file is completed at which time the beginning of the LTSA plot should be displayed in the Plot Window.

Using LTSA files

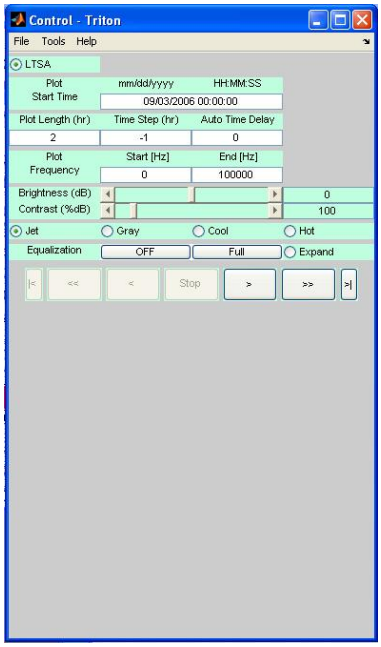
After an LTSA file is created, (see previous section) the LTSA plot will be displayed in the Plot Window and the first step below can be omitted.

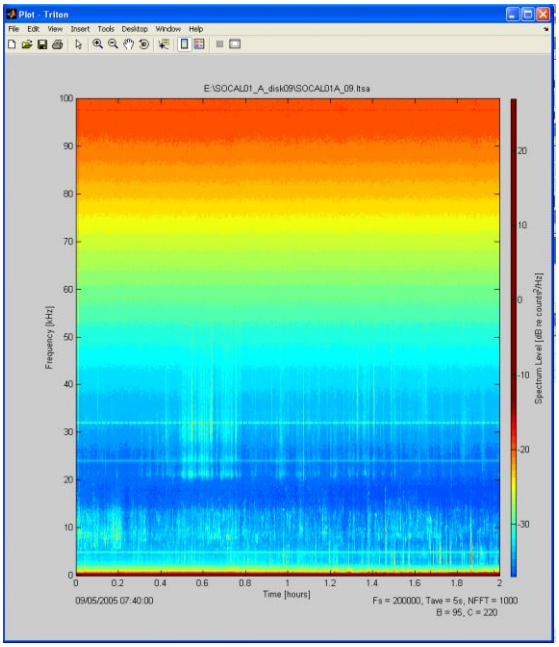
Selecting an LTSA file

- To open an LTSA file, select **Open LTSA** File from the File pull-down menu in the Control Window.



- After opening the file, the Control Window will be populated with LTSA options only (light green), and the Plot Window will display the beginning of the LTSA plot.





- Navigate through the LTSA in the Plot Window using the buttons in the Control Window.
  - < > - Advance one frame left or right.
  - << >> - Automated advancement through frames. Click the Stop button to end automated advancement. Time of plot will be updated on the Control Window Plot Start Time.
  - |< >| - Jump to the beginning or end of the data.

LTSA Plot Control Settings

LTSA Plot settings can be adjusted in the Control Window. Additional options, not shown here, exist for color scheme, brightness, and contrast – see preceding section for Control Window.

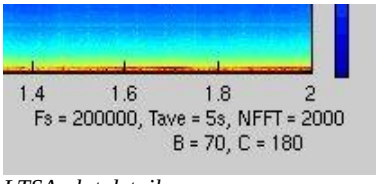
For example,

- Plot Length = 2 hrs
- Time Step = -1 hrs (Plot advances full time-plot length forward when stepping.)
- Plot Frequency = 0 to 100,000 Hz.

Plot Details

Details about the LTSA plot are displayed on the LTSA Plot Window. This information is set when the LTSA file is generated.

- **Fs** – sample rate
- **Tave** – time average used to create **LTSA**. In this example, 5 seconds of data were averaged into one time bin.
- **NFFT** – FFT size
- **B** - brightness
- **C** - contrast

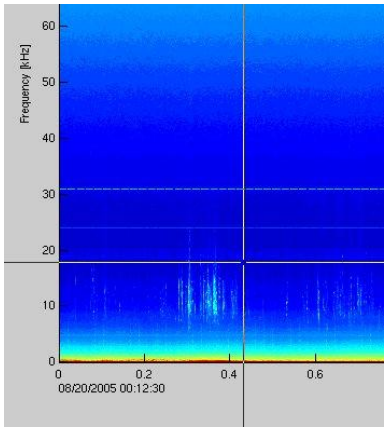


LTSA plot details

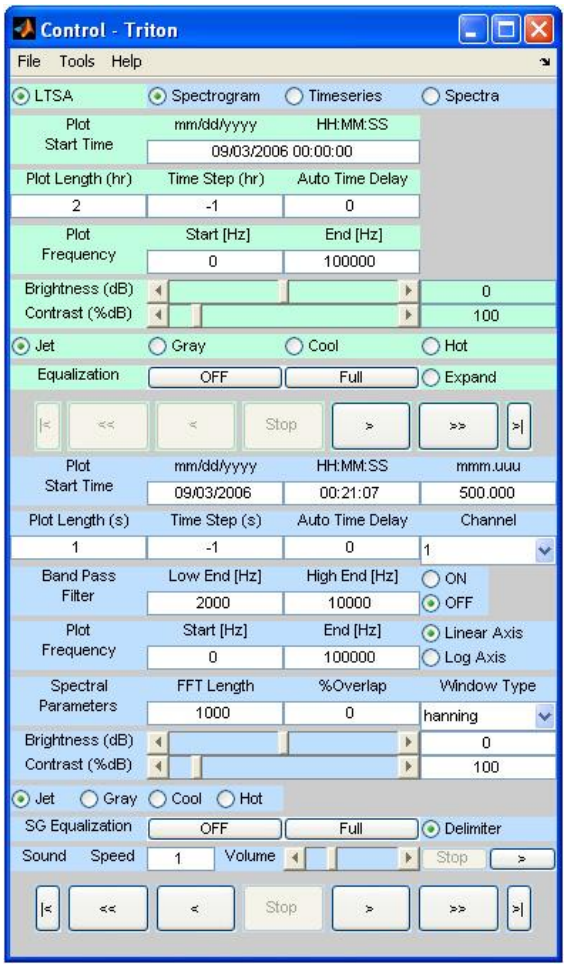
Selecting a region of the LTSA for detailed analysis

- Advance to an area of interest in the LTSA plot using the advance buttons.
- Click **Enlarge** button on the Control Window.

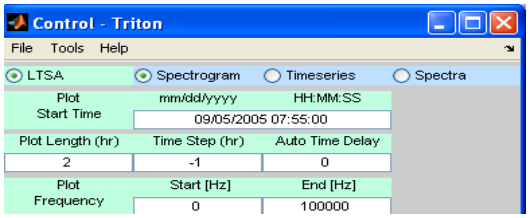
- Place the cursor over the LTSA plot. There should be cross-hairs at the cursor location.
- Click the mouse and wait a couple seconds. A spectrogram will be generated below the LTSA plot for the XWAV data corresponding to the selected time.



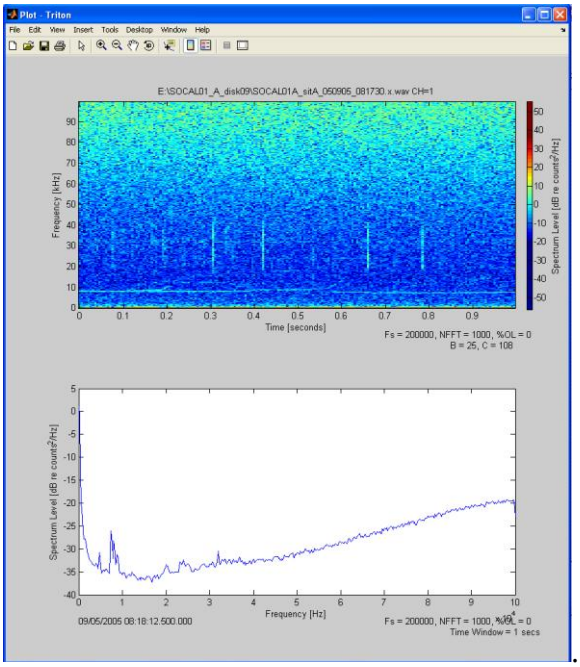
- The Control Window will be updated with spectrogram options for the XWAV file opened. These options will be displayed with a light blue background.

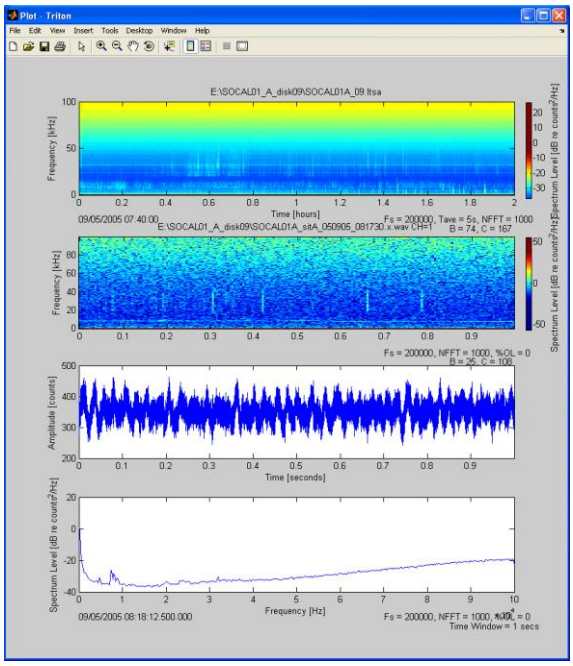


- To generate Timeseries and Spectra plots, click the **Timeseries** and **Spectra** buttons in the Control Window. This will load the additional plots in the Plot Window and update the plot options in the Control Window.



- To display any combination of plots, select or de-select the **LTSA**, **Spectrogram**, **Timeseries**, or **Spectra** buttons on the Control Window.





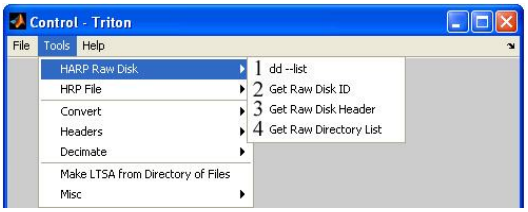
- (Note: If you advance through the LTSA, the spectrogram will not be updated until you click **Enlarge** and select another event of interest in the LTSA plot which will load the corresponding spectrogram.)

Triton Tools

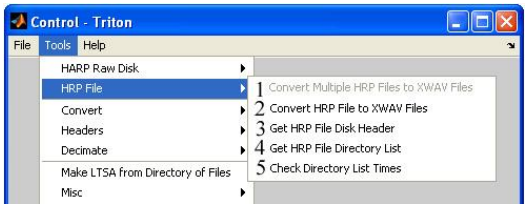
Tools Pull-Down Menu Overview

This is a breakdown of the tool pull-down menu, each sub-menu is described in greater detail in their separate sections below.

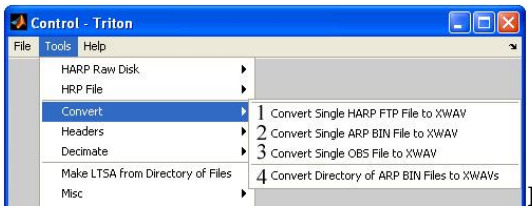
A.



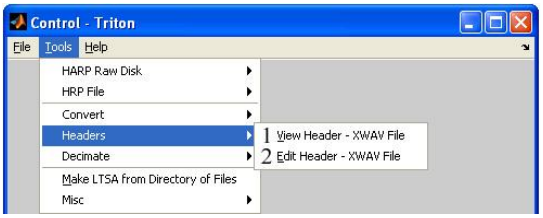
B.



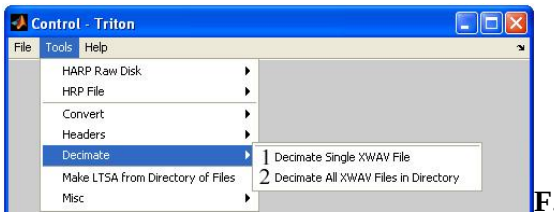
C.



D.

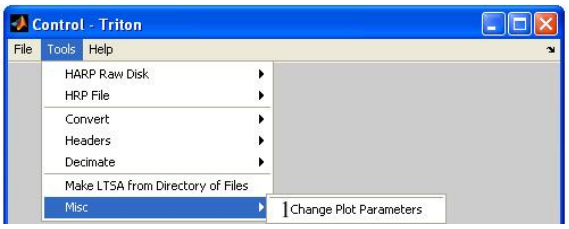


E.



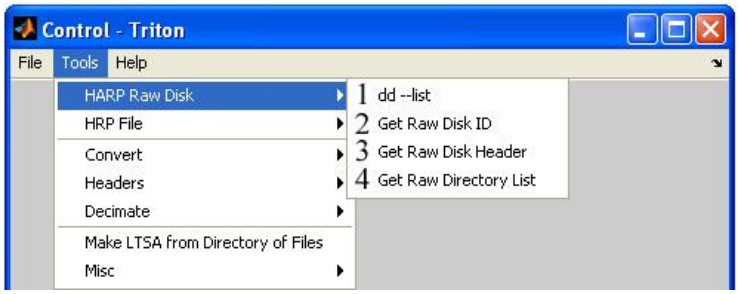
F.

G.



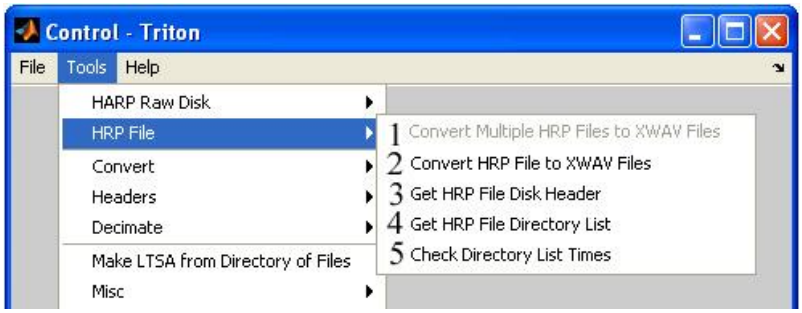
A) HARP Raw Disk
B) Raw HARP file operations
C) Convert various file formats to XWAV format
D) View and edit XWAV file headers
E) Decimate XWAV files
F) Creates new LTSA file from a directory of XWAV or WAV files, see LTSA section below for more information.
G) Manual/Auto change time series and spectral plot axes

HARP Raw Disk

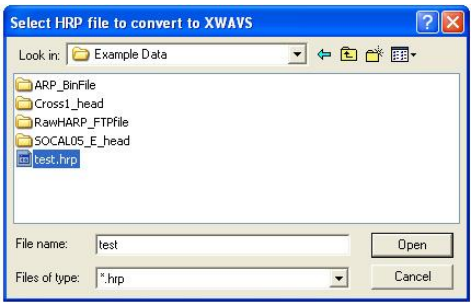


1) This tool does not yet work.
2) This tool does not yet work.
3) This tool does not yet work.
4) This tool does not yet work.

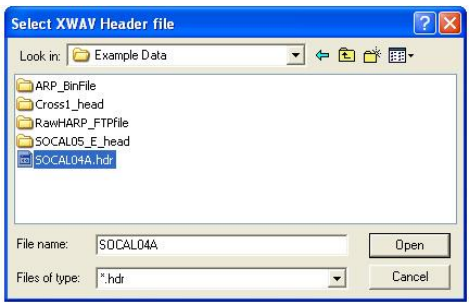
Harp File Operations



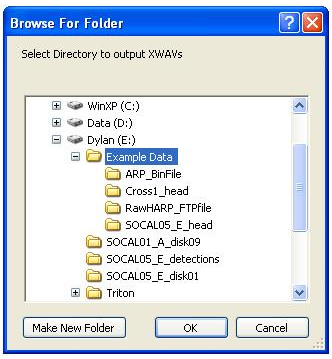
1)
2) Select the *.hrp file you wish to convert.



Select the *.hdr file that corresponds to the *.hrp file

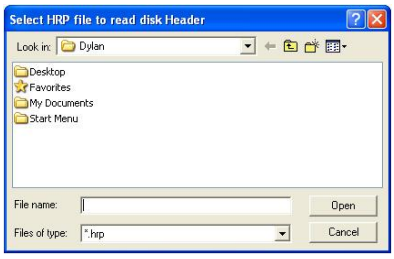


Choose a file to save them in.



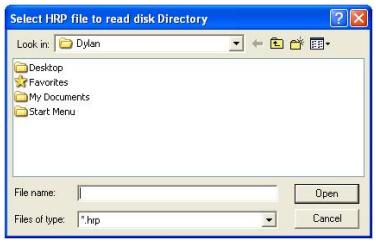
3) Gets the HRP disk file headers.

First you must find the HRP disk to get the file header from.

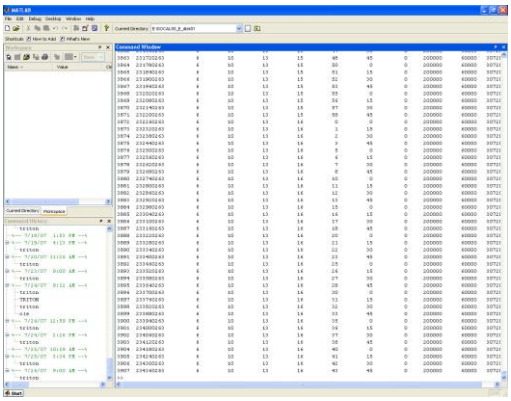


The header information is displayed In the message window.

4) Gets the HRP disk file directory.



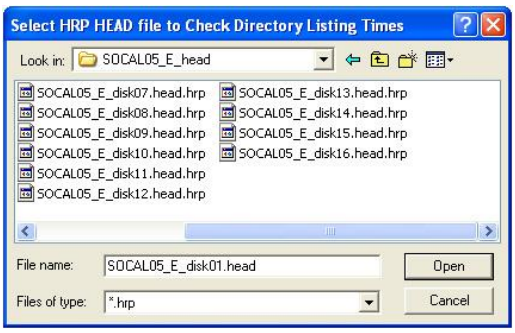
The information is displayed on the MATLAB command window. This process takes up to a minute or two depending on file size. The 12 columns for each raw file (row) represent, file number, file name, year, month, day, hour, minute, second, millisecond, sample rate, number of sectors, and number of bytes.



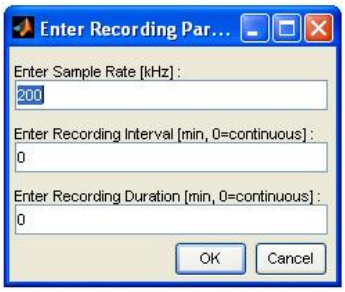
5) Checks the directory list times.

Choose either one file or whole directory, 1 denotes 1 file while 0 is used for a whole directory.

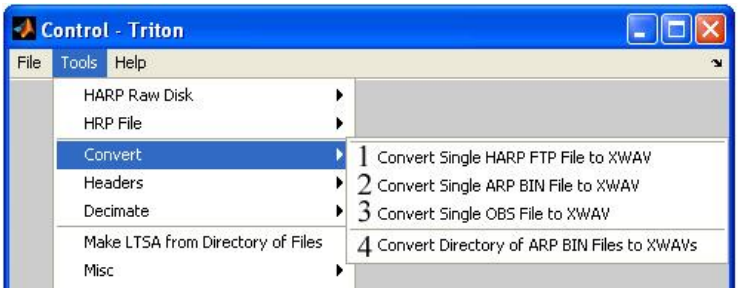
Select the HARP head file.



Now you enter the sampling rate and the recording interval and duration. 0 is used for continuous recordings. Example if the HARP is recording for 5 minutes and is off for 20 than the interval would be 25, and the duration would be 5.

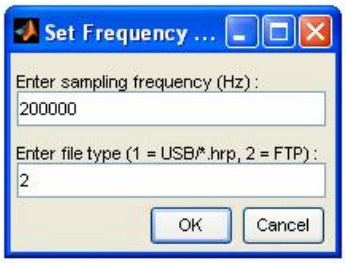


Converting Files to XWAV Format

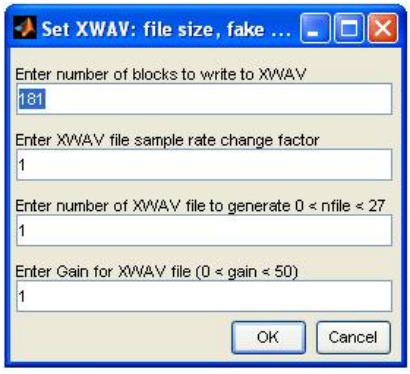


1) Converts a single HARP FTP file to an XWAV file. Use this function after off loading a raw file from a data logger e.g. during a deck or lab test.

Type in the sampling frequency, which will be recorded in the XWAV file, and the file type; USB or FTP.

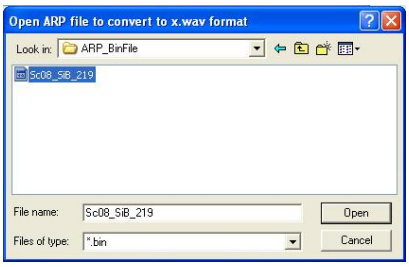


Input the remaining statistics for the new XWAV file, the number of blocks, sample rate change factor, The number of XWAVs to make, and the Gain of the XWAV.

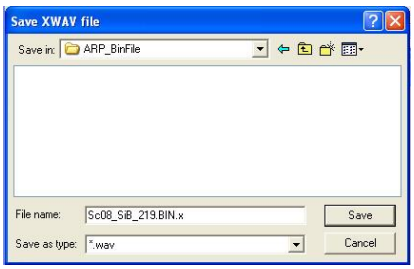


2) Converts 1 ARP BIN file to an XWAV file.

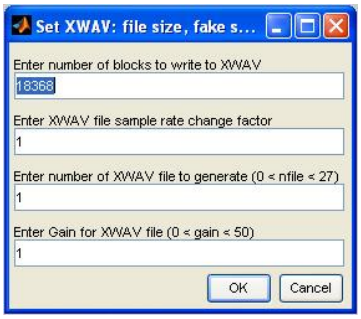
Find the ARP file you want to convert, highlight it and click 'Open'.



Find the file you wish to save the ARP in and choose a name for the new XWAV file.



Set the XWAV parameters, the number of blocks with which to write the XWAV, the sample rate change factor, the number of XWAV files to make, and the Gain of the XWAV.

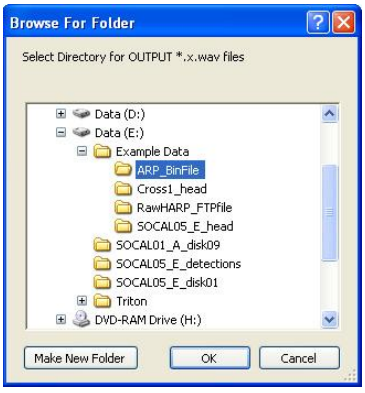


3) Converts 1 OBS file to an XWAV file.

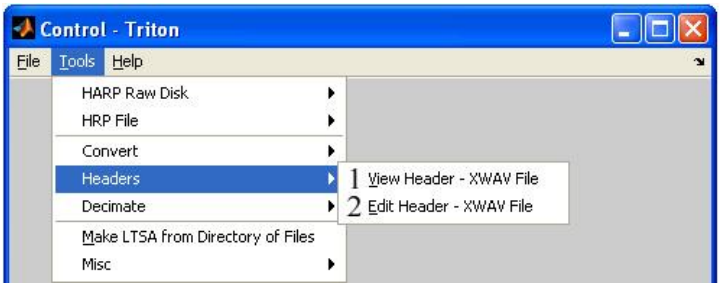
4) Converts a directory of ARP BIN files to XWAV files.

Choose the directory you wish to convert.

Choose the directory in which to save the converted files, this could take a couple minutes to complete.

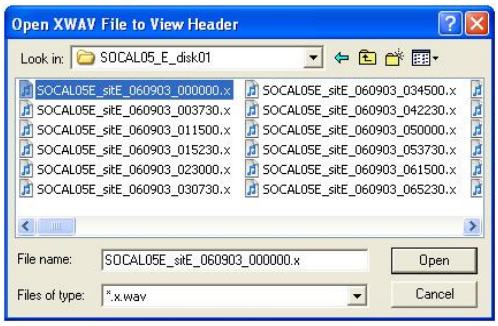


View and Edit XWAV File Headers

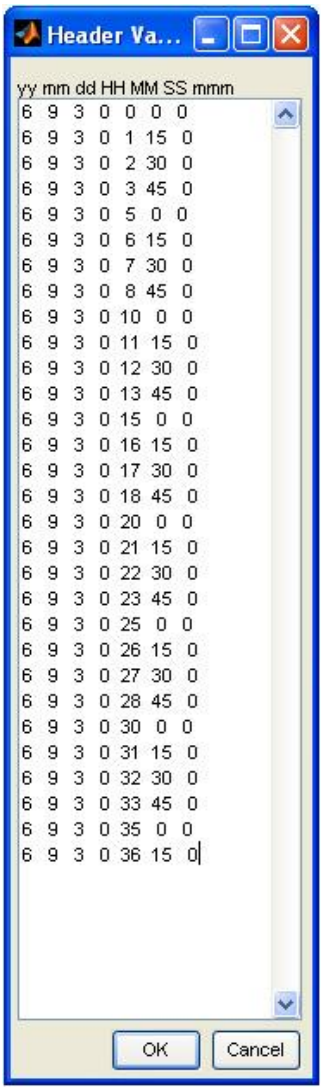


1) Allows the user to view the header of the current XWAV file open in the plot window.

Choose the XWAV file you wish to open.



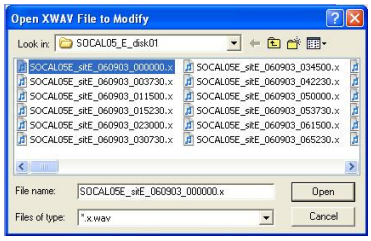
The data is displayed in a long narrow window in the format, year, month, day, hour minute, second and millisecond.



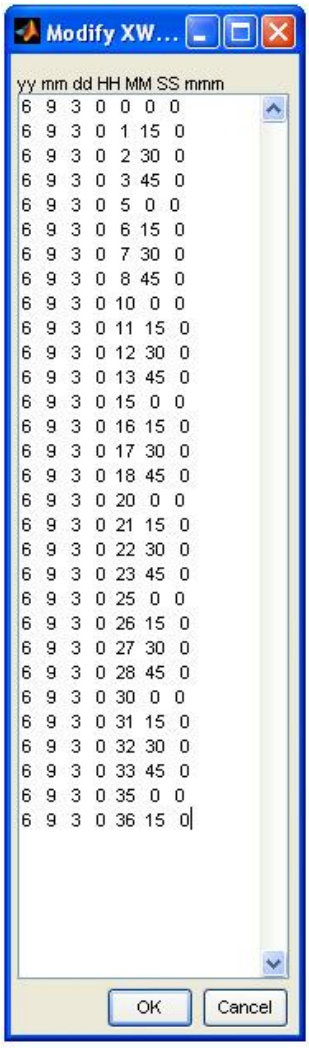
2) Allows the user to edit the header of the

current XWAV file open in the plot window.

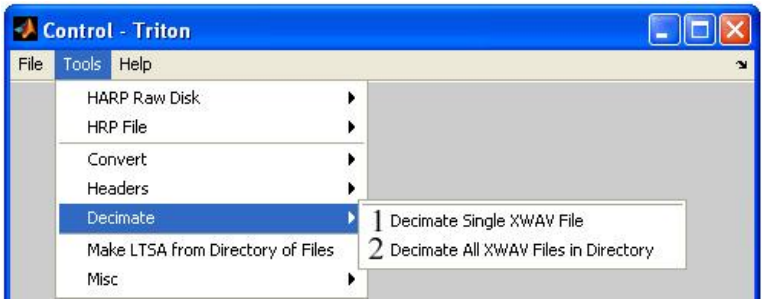
Choose the XWAV file you wish to edit.



The data is displayed in a long narrow window in the format, year, month, day, hour minute, second and millisecond, now just erase and write over the data with the new information.

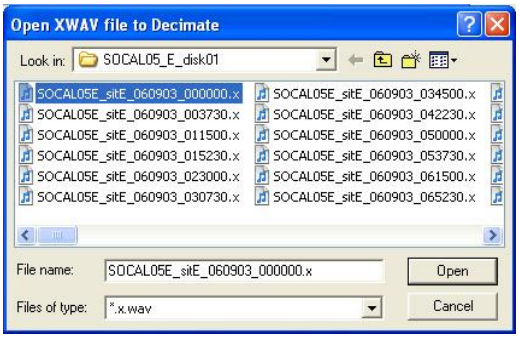


Decimate XWAV Files

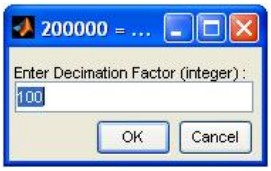


1) Decimates a single XWAV file

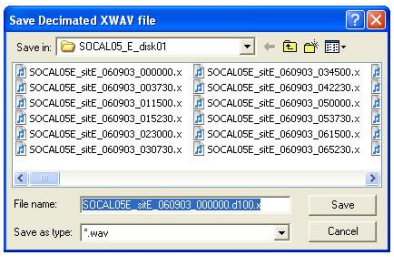
Highlight the XWAV file you wish to decimate, and click 'Open'.



Enter the Decimation factor (must be an integer). This is the level of decimation, for example a decimation factor of 100 would be 100 times less memory intensive than the original file.

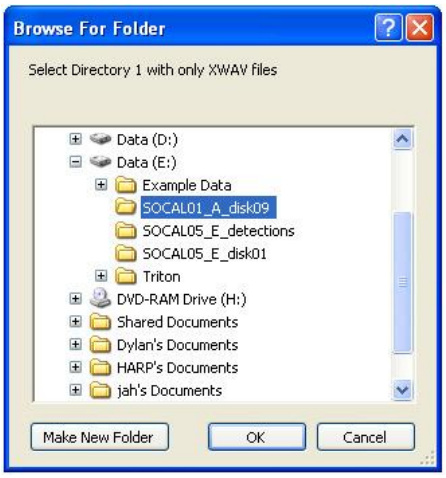


Name the new decimated file, and choose where to save it.

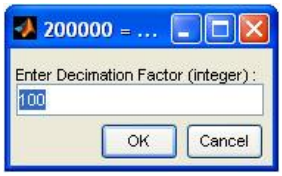


2) Decimates all XWAV files in the directory.

Highlight the XWAV directory you wish to decimate, and click ‘Open’.



Enter the Decimation factor (must be an integer). This is the level of decimation, for example a decimation factor of 100 would be 100 times less memory intensive than the original file.



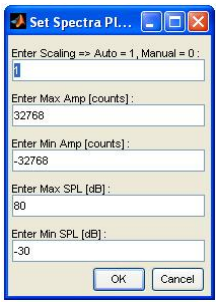
Choose where to save the newly decimated XWAV files.

Creates New LTSA File

Creates new LTSA file from a directory of XWAV or WAV files, see LTSA section above for more information.

Change Plot Parameters

1) The Change Plot Parameters tool is applied to time series and spectral plots only. MATLAB's default is to automatically scale plots. When set to manual the plot scaling is held constant to maximum and minimum values chosen by the user. The plot parameter scaling are:



- Max Amp [counts]
- Min Amp [counts]
- Enter Max SPL [dB]
- Enter Min SPL [dB]

Transfer Function

Transfer Function Overview

To make physical measurements, data logging systems can be used with sensors. In the case of a HARP system, pressure (µPa) is measured using a hydrophone sensor and the data are stored on hard disk drives. Two main conversions occur within this system. The first is at the hydrophone where time-varying pressure is converted to time varying voltage, amplified and filtered providing a frequency dependent response to pressure. The second conversion is in the data logger where the analog voltage signal is digitized and stored. The details of these conversions are often described in a *Transfer Function* and must be applied in reverse to correct the recorded data back into meaningful physical units.

Since XWAV data files units are in A/D [counts] and the physical units of pressure are in [µPa], the transfer function is described as 1/sensitivity [dB re uPa(rms)^2/counts^2] and is frequency dependent. Currently in Triton, the transfer function is only applied to spectra plots, not LTSA, spectrogram nor time series plots. The transfer function is applied to spectra plots via an user generated transfer function (TF) file consisting of columns of Frequency [Hz] and 1/sensitivity [dB re uPa(rms)^2/counts^2] in an ascii text format with extension *.tf.

Transfer Function Calculation

The 1/sensitivity for a TF file is calculated via the negative of the sum of the following four transfer function components:

1) Sensor (Ceramic/PZT/hydrophone)
[dB re Vrms^2/ uPa(rms)^2] Open Circuit Received Response

2) Preamp + Filter Board Gain (usually frequency dependent i.e., freq column in TF file)
[dB]

3) Analog to Digital Converter (A/D)
[dB re counts^2/Vp-p ^2]

4) Vp-p / Vrms (This is needed because the TF file 1/sensitivity values are applied to the output of the power spectrum. This would not be added if the TF was applied to the time series, directly):
9.0 [dB re Vp-p^2/Vrms^2] = 10*1og10((1.414 * 2)^2)

or

Sensitivity = [dB re counts^2 /uPa(rms)^2]

+ [dB re Vrms^2/uPa^2]	Sensor
+ [dB]	Preamp+Filter Gain
+ [dB re counts^2/Vp-p ^2]	A/D converter
+ 9.0 [dB re Vp-p^2/Vrms^2]	Vp-p/Vrms

Example Transfer Function calculation:

AQ-1 & 1042: ~ -200 dB re Vrms/uPa(rms)
400 series board: +40+15 dB low / +80 dB high
A/D: +82 dB re counts^2/Vp-p^2
p-p2rms: +9 dB re Vp-p^2/Vrms^2

= -(-200 +55/+80 +82 +9) = +54/+29 dB re uPa(rms)/counts^2

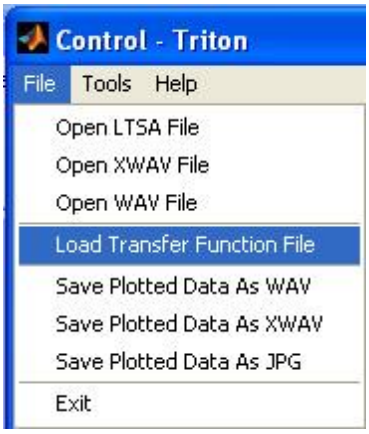
Important: Don't forget it's the negative of the sum of the sensitivity to get the units correct for 1/sensitivity.

For more detailed description of TF calculations see Triton subroutine loadTF.m.

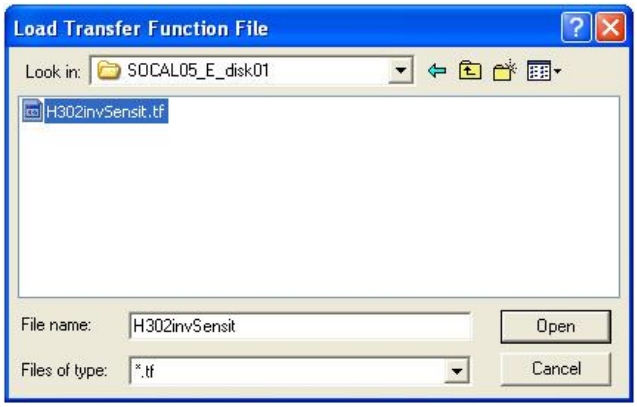
Applying Transfer Functions

- Open an XWAV file (if not already opened)

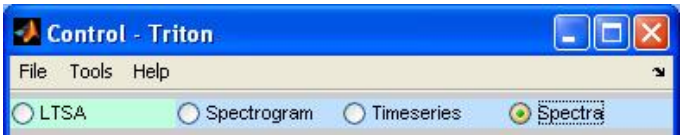
- Click the 'Load Transfer Function File' under the control file pull-down menu.



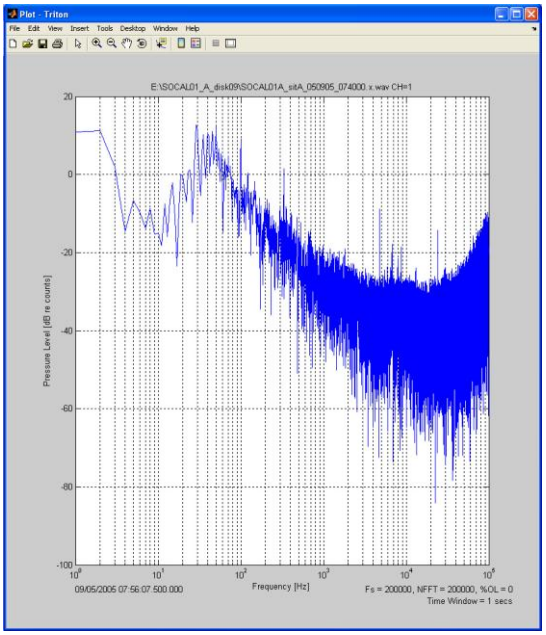
- Choose the transfer function file and select 'Open'.
- The transfer function is now loaded, but not applied



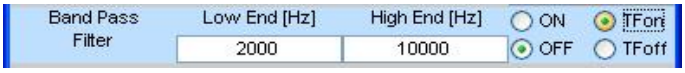
- Turn on Spectra (turn off LTSA, Spectrogram, and Timeseries) with the toggle buttons.



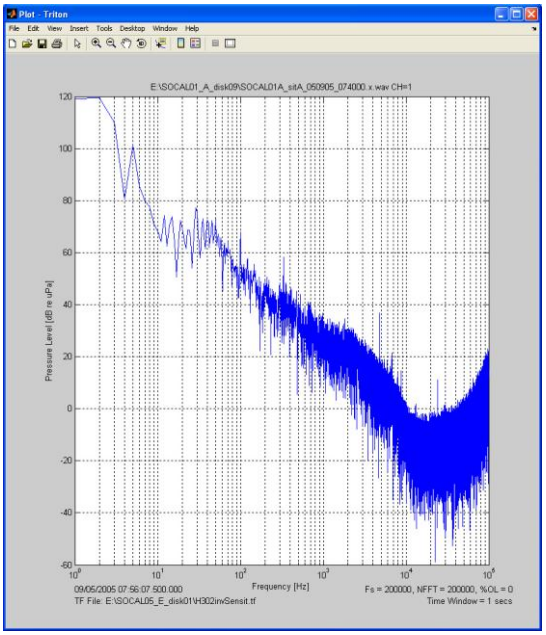
- Set Spectral parameters in the Control Window. Set FFT Length to the sample rate to get 1 Hz bins for spectra level.



- In the Control Window, toggle the TF on button.



- Notice the change in spectral shape between TF on and TF off.



Logger Function

Overview

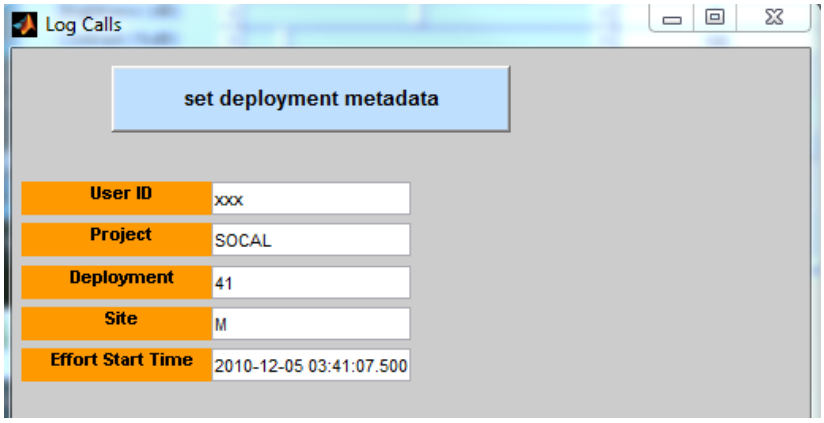
In Triton, using the logger function allows for the recording of anthropogenic, marine mammal, fish, and unknown sounds recorded in the marine environment. This interactive version of Triton allows for specifying effort (what species or call types you are looking for in the data set) as well as the ability to include ad hoc detections. The ability to specify effort is important in that it allows the user to indicate which species or call types are being looked for in the data set, which becomes important in future analyses and projects.

Getting Started

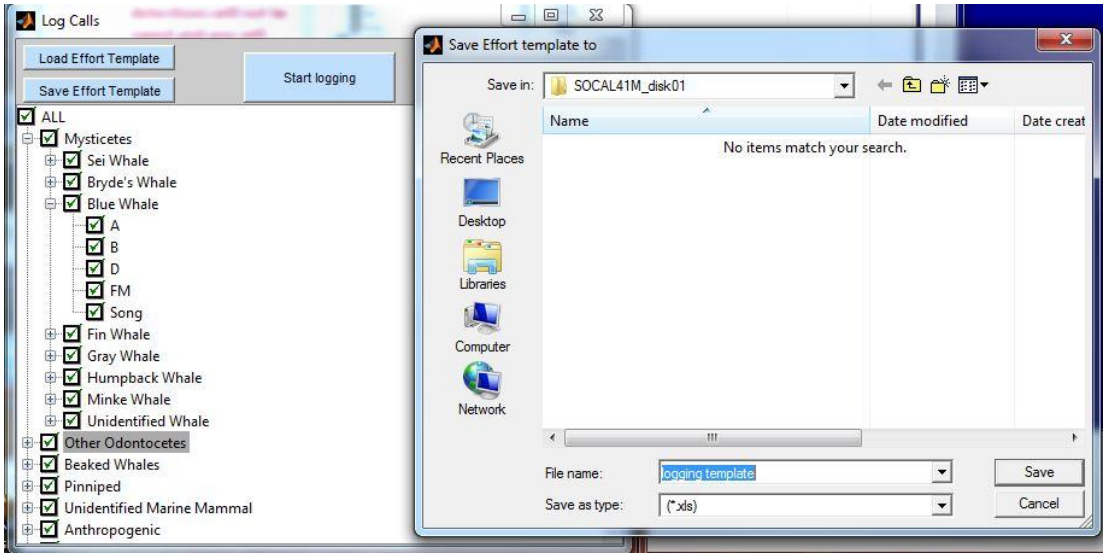
Under "Tools" in the control window, select the "Log" button, where your options will be to create a "New log" or "Continue existing log"

If "new log" is selected, a file dialog will allow you to specify where you want the log to be saved. Type in the filename you want to create (i.e. SoCal40M_highfrequency_yourinitials.xls)

-A window will open where you can input information about the data that will be searched for acoustic events. You will be asked to specify your User ID which can be anything you would like such as your initials and last name, e.g. jsmith. The project, deployment number, and site refers to where the data was collected and what larger project it is a part of, e.g. SOCAL (project) 41 (deployment) M (site). Effort start time is the time in the LTSA at which you start looking for detections, and is picked using the cursor in the LTSA window.

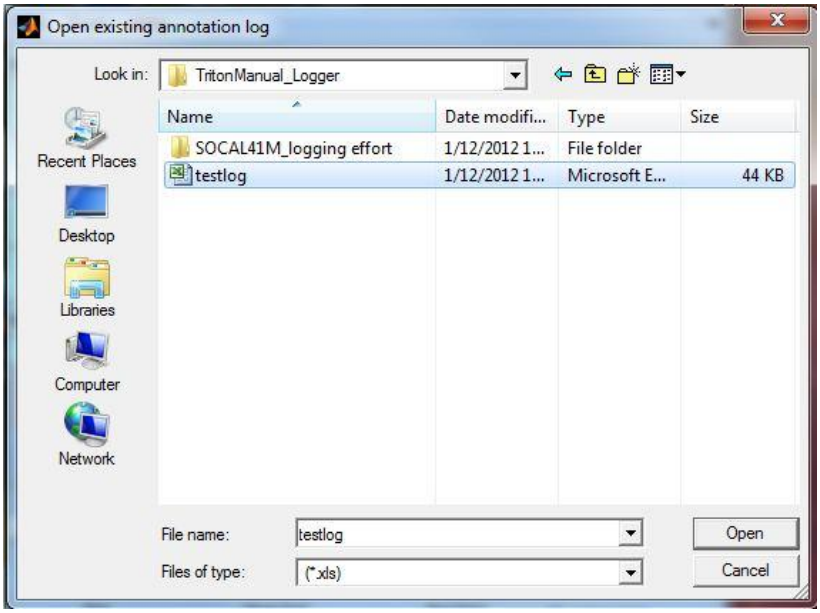


- Next, a list of species and groups will appear. Clicking on the species (or species group) will put a check mark on it and it will appear in the effort section of your log file.
- Once you have selected the species you plan on logging in the data set, click the "Save effort" button. This will create a template for future use with your species and call type specifications that can be retrieved via the 'Load effort template' button.
Finally, click "Start logging" to begin.
- This will create a spreadsheet file and two folders with names similar to the spreadsheet.



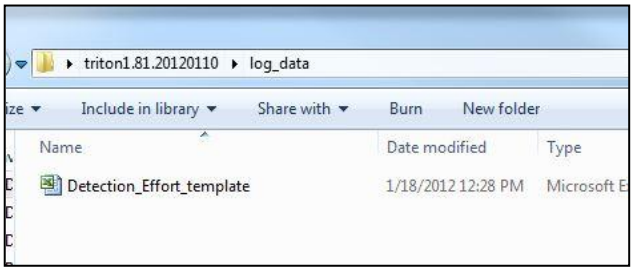
<u>Important</u>: If you are using a development version of the logger, the workbook will open in Microsoft Excel. Do not close the workbook or modify it in any way while you are logging detections or you will be likely to corrupt your logging session. The workbook will close automatically when you finish logging.

If "continue existing log" is selected, locate the Excel file in the directory it was last saved, and open. The effort previously set for this log will automatically load.



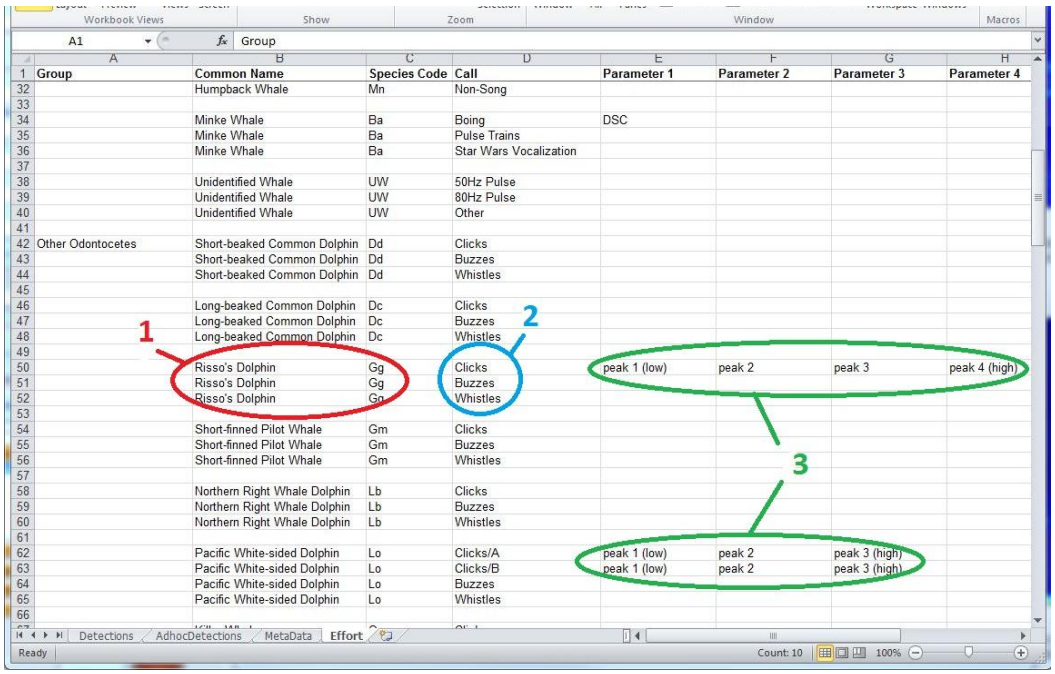
More about the Template and recording effort

The 'Detection_effort_template' file can be found in the 'triton>log_data' directory and shows the list of species (1) and call types (2) available to log in Triton. It also shows which species have frequency parameters that can be selected (3) and provides a description of what the different parameters represent depending on what species is detected.



This can be modified to support activities appropriate for your group, and the changes will appear in the next invocation of logger.

Tracking effort is very important for passive acoustic monitoring. Suppose that we are detecting Common Dolphins (*Delphinus sp.*) off the coast of Southern California and we had detections in January and February. Without knowing over what timespan we looked, it would be impossible to say anything more than that they were present in those months only, all year, or part of a migration pattern.



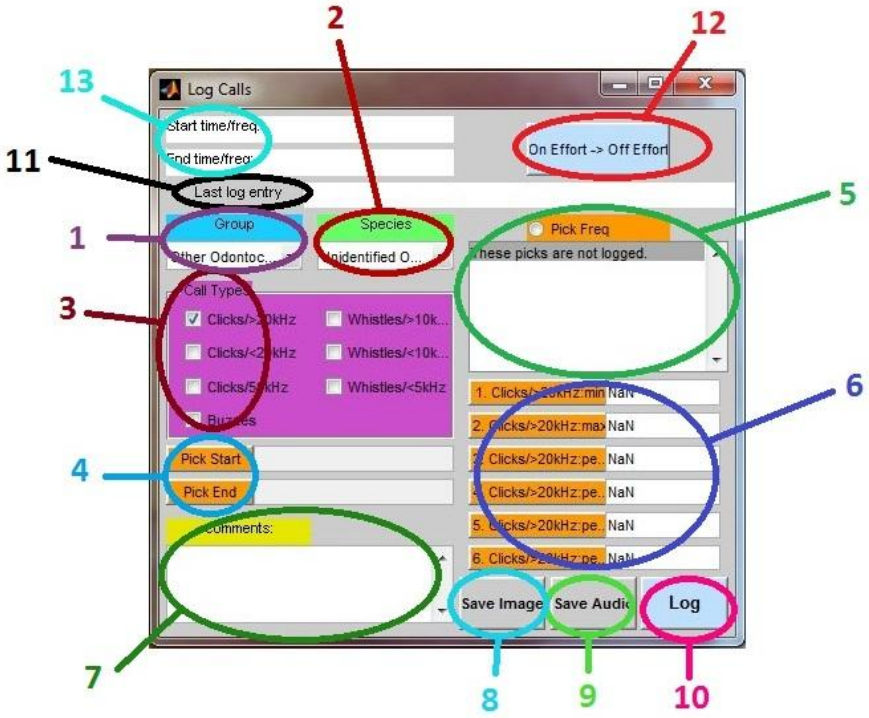
	Group	Common Name	Species Code	Call	Parameter 1	Parameter 2	Parameter 3	Parameter 4
32		Humpback Whale	Mn	Non-Song				
33								
34		Minke Whale	Ba	Boing	DSC			
35		Minke Whale	Ba	Pulse Trains				
36		Minke Whale	Ba	Star Wars Vocalization				
37								
38		Unidentified Whale	UW	50Hz Pulse				
39		Unidentified Whale	UW	80Hz Pulse				
40		Unidentified Whale	UW	Other				
41								
42	Other Odontocetes	Short-beaked Common Dolphin	Dd	Clicks				
43		Short-beaked Common Dolphin	Dd	Buzzes				
44		Short-beaked Common Dolphin	Dd	Whistles				
45								
46		Long-beaked Common Dolphin	Dc	Clicks				
47		Long-beaked Common Dolphin	Dc	Buzzes				
48		Long-beaked Common Dolphin	Dc	Whistles				
49								
50		Risso's Dolphin	Gg	Clicks	peak 1 (low)	peak 2	peak 3	peak 4 (high)
51		Risso's Dolphin	Gg	Buzzes				
52		Risso's Dolphin	Gg	Whistles				
53								
54		Short-finned Pilot Whale	Gm	Clicks				
55		Short-finned Pilot Whale	Gm	Buzzes				
56		Short-finned Pilot Whale	Gm	Whistles				
57								
58		Northern Right Whale Dolphin	Lb	Clicks				
59		Northern Right Whale Dolphin	Lb	Buzzes				
60		Northern Right Whale Dolphin	Lb	Whistles				
61								
62		Pacific White-sided Dolphin	Lo	Clicks/A	peak 1 (low)	peak 2	peak 3 (high)	
63		Pacific White-sided Dolphin	Lo	Clicks/B	peak 1 (low)	peak 2	peak 3 (high)	
64		Pacific White-sided Dolphin	Lo	Buzzes				
65		Pacific White-sided Dolphin	Lo	Whistles				
66								

Quick Guide to Logging a Call

To log calls detected in any of Triton's displays: Assuming that the detection was made for a species that was part of the effort, verify that logger is in the "on-effort" mode. Button (**12**)'s label should read: 'On effort → off effort'. If it does not, click on it to leave off-effort mode. Then select the group (**1**) that the species is a part of by clicking on the drop-down tab. Once the group is selected, click on the drop-down tab to select for the species (**2**) then click the box indicating call type (**3**).

Start and end time of the call (**4**) should be recorded by clicking the start time in the LTSA or XWAV and then the 'pick start' or 'pick end' button. Minimum/maximum frequency or other parameters (**6**) that have been selected with the cursor in the LTSA or XWAV can first be previewed in the box under

the ‘pick freq’ button (**5**) . You will also be able to preview start and end time and minimum/maximum frequency of the most recent selection in the LTSA or XWAV window in the upper left hand corner (**13**) of the window.
Enter any additional information about the pick into the comment (**7**) box if desired and click ‘save image’ or ‘save audio’ (**8, 9**) to save a JPEG or WAV file of the current screen . Once all of these steps have been completed, click ‘log’ (**10**) to log your call. The data you just saved will show up in the ‘last log entry’ (**11**) box.



As moving back and forth between the Log Calls window and the plot window can take time, most of the functions of the log calls window have corresponding hot keys that can be used when the plot window is active. These are summarized in Table I and described below.

Table 1.

Hotkey	**Description**
S	Record selected start time of detection
E	Record selected end time of detection
F	Turn ‘Pick freq’ preview function on or off
B	Records start/end time and min/max frequency of a rectangular or box selection in the LTSA
1,2…6	Record frequency parameters (min/max/peak)

<u>More information about the “Log Calls” window:</u>

1**. Group:** Displays the groups that were selected in a drop down tab. Selecting one by clicking on it will update the ‘Species’ and ‘Call Types’ section.

2**. Species:** Displays the species that were selected in a drop down tab. The species available is according to the Groups selected. Selecting a species will update the ‘Call Types’ section.

3**. Call Types**: This section displays the Call types associated with the specified species(2). To select a call type, clicking on it will put a checkmark (or uncheck if it was already checked) on the call. The Param(1) section will then be updated to display the Call Type's specific Parameters if it has any. Note: selecting a new call type updates the Param(1) section, you will not be able to change the previous params as clicking on a checked call type will uncheck it and reset all the values in the params.

4**. Pick Start/End**: This records the start and end time of a frequency being recorded. To use: Click the "Pick Start" button to record the start time. Then click the "Pick End" button to record the end time. You can also use the hotkey: "**S**" for Pick Start and "**E**" for Pick End. In addition, you can use the hotkey 'B' to record both start and end time. This will also set the minimum and maximum frequencies if they appear in the call parameter list.

5**. Pick Frequency:** This allows you to preview the frequency before you select it for your parameters. To use: click on the Pick Freq button (or press the hotkey: "**F**") to toggle the function on and off. The mouse selector will turn into crosshairs on the Plot window when Pick Freq is on

6. **Call Parameters**: these consist of parameters that are associated to the call type currently selected. If no Parameters are specified in the template there will be a default of 6 Parameter buttons. To use: simply click on the Param button you want to store the info in or use the hotkey: **numbers 1-6**.

7. **Comments**: Any additional information or comments about the data should be recorded here.

8. **Save Image**: this saves the current display in the Plot window as a .jpg image (labeled: 'species-ProjectDeploymentSite-LogStartTime.jpeg') to a folder named "yourlogname-image". The image save button will indicate that the image has been saved and allows you to clear the data before logging if it was hit by mistake.

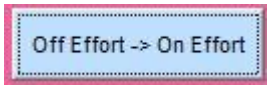
9. **Save Audio**: this saves the current Plot Length as an XWAV (labeled: 'species-ProjectDeploymentSite-LogStartTime.xwav') to a folder named "yourlogname-audio". The audio save button will indicate that the audio file has been saved and allows you to clear the data before logging if hit by mistake.

10. **Log**: After you have selected the group, species, call type, parameters, and saved any audio or images, press "Log" to save the data onto the log spreadsheet. If 'Call Type' or 'Pick Start' are not selected, the data will not log and you will be prompted to enter values for those boxes.

11. **Last log entry**: after Logging data into the log spreadsheet all the fields will clear and the newly added log will appear in Previous Picks.

12. **Effort on →off**: This allows you to switch between on and off effort detections. The first phrase in the box indicates whether you are currently on or off effort and the arrow shows what the new state will be if the button is clicked/ Going off effort will allow you to log entries for any of the species that could have been selected at the time effort was specified. As off-effort detections cannot usually be used for statistical analysis, the log window background is set to a bright color to remind you that you are off effort.

Example of On Effort, clicking will go Off Effort.

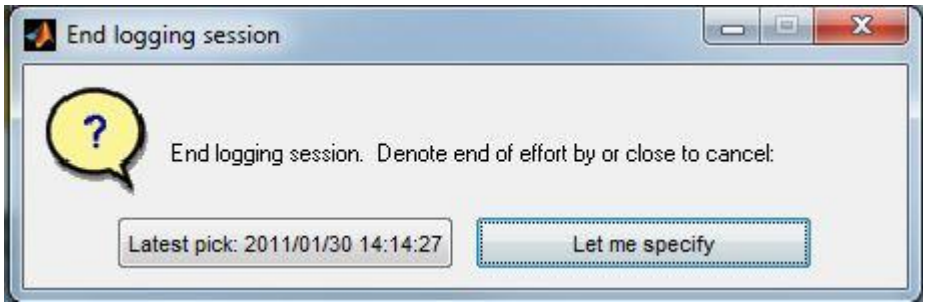


Example of Off Effort, clicking will go On Effort.

13. **Start/End Time/Freq**: These boxes in the upper left corner of the logger window show the current selections for start/end time and frequency. If a single point is selected they will be identical, but by dragging out a rectangular shape in the LTSA or XWAV plot and then clicking hotkey: '**B'** (for 'box') the start/end time and min/max frequency will automatically be filled in to the appropriate box.

Ending the Log Session

To end your log session you must click the 'X' in the upper right corner of the 'log calls' window, which will bring up a new window asking you to denote the end of effort. To set the end of effort to the time of the last detection, select 'latest pick'. Selecting 'let me specify' brings up a window that lets you specify a time by clicking in the plot window or typing an end time. If you are continuing a log from a previous session, you will also have the opportunity to use the existing end date if there are no log entries after it.



Appendix A1- HARP Data Logger Disk Format

1 Raw HARP disk 120 GB	Header	Disk Header	Sector 0
			Sector 1
			Sector 2
		Directory Listing	Sector 3-7
			Sector 8-x
	Data	1 Raw HARP file	Sector x+1
			Sector x+2
			. . .
			Sector x+60,000

Raw Disk Size	X	N
120 GB	263	3873
100 GB	222	3207
80 GB	181	?

	Field Name *PARAMS.head.*	Length in Bytes	Start	End	Format	Example
Disk Header						
Sector 0	disktype	4	0	3	uint8	'HARP Disk #16'
	unused	7	4	10	uint8	" Disk # "
	disknumberSector0	2	11	12	uint8	16
	unused	499	13	511	uint8	
Sector 1	unused	512	0	511	uint8	
Sector 2	nextFileSector	4	0	3	uint8	234420263
	(write_byte)	2	4	5	uint8	0
	unused	4	6	9	uint8	
	unused	2	10	11	uint8	
	firstDirSector	4	12	15	uint8	8
	maxFile	4	16	19	uint8	3908
	currDirSector	4	20	23	uint8	252
	nextFile	4	24	27	uint8	3907
	unused	4	28	31	uint8	
	unused	4	32	35	uint8	
	unused	4	36	39	uint8	
	unused	4	40	43	uint8	
	unused	4	44	47	uint8	
	unused	4	48	51	uint8	
	unused	4	52	55	uint8	
	unused	4	56	59	uint8	
	firstFileSector	4	60	63	uint8	263
	samplerate	4	64	67	uint8	200000
	disknumberSector2	2	68	69	uint8	16
	firmwareVersion	10	70	79	uint8	1.17
	description	80	80	159	uint8	"No Description"
	unused	2	160	161	uint8	
	unused	2	162	163	uint8	
	unused	2	164	165	uint8	
	unused	2	166	167	uint8	
	unused	2	168	169	uint8	
	unused	2	170	171	uint8	
	disksizeSector	4	172	175	uint8	234441643
	unusedSector	4	176	179	uint8	21383
	unused	2	180	181	uint8	
	unused	2	182	183	uint8	
	unused	328	184	511	uint8	

	Field Name *PARAMS.head.*	Length in Bytes	Start	End	Format	Example
DIR List						
Sector 8 *these are PARAMS. head.dirlist*	(year)	1	0	0	uint8	7
	(month)	1	1	1	uint8	15
	(Day)	1	2	2	uint8	31
	(hour)	1	3	3	uint8	23
	(min)	1	4	4	uint8	59
	(secs)	1	5	5	uint8	59
	(msecs)	2	6	7	uint8	999
	(blk_number)	4	8	11	uint8	120263
	(num_blocks)	4	12	15	uint8	60000
	(rec_length)	4	16	19	uint8	30720000
	(samole_rate)	4	20	23	uint8	200000
	unused	2	24	25	uint8	
	spare	6	26	31	uint8	
DATA Repeated for each raw file, usually 60,000X						
firstFile Sector	Year	1	0	0	uint8	7
	Month	1	1	1	uint8	15
	Day	1	2	2	uint8	31
	Hour	1	3	3	uint8	23
	Min	1	4	4	uint8	59
	Secs	1	5	5	uint8	59
	Msecs	2	6	7	uint8	999
	Unused	2	8	9	uint8	
	Num_samples	2	10	11	uint8	250
	Data samples*	500	12	511	uint16	

Notes

- 1 byte = 8 bits
- 1 sector=512 bytes
- 1 Rawfile = 60,000 sectors
- for additional information see comments in: read_rawHARPdata.m, read_rawHARPdir.m, read_rawHARPhead.m, and hrp2xwav.m
- HARP Data are recorded with Motorola CPU (little Endian) and some 2 byte, 4 byte words need to be swapped at byte level

Appendix A2- XWAV File Format

1 XWAV file	Standard WAV header	RIFF header
		Format Chunk
	Additional XWAV header	HARP Chunk
	XWAV directory	HARP dir subchunk 1
		HARP dir subchunk 2
		. . .
		HARP dir subchunk 30
	Data	Data Chunk 1
		Data Chunk 2
		. . .
		Data Chunk 30

	Field Name *PARAMS.xhd. precedes each*	Length in Bytes	Start	End	Format	# of Elements	Example
Standard WAV header							
Riff Header	ChunkID	4	0	3	uchar	4	"RIFF"
	ChunkSize	4	4	7	uint32	1	filesize-8
	Format	4	8	11	uchar	4	"WAVE"
Format Chunk	fSubchunkID	4	12	15	uchar	4	"fmt "
	fSubchunkSize	4	16	19	uint32	1	16
	AudioFormat	2	20	21	uint16	1	1
	NumChannels	2	22	23	uint16	1	1
	SampleRate	4	24	27	uint32	1	200000
	ByteRate	4	28	31	uint32	1	400000
	BlockAlign	2	32	33	uint16	1	2
	BitsPerSample	2	34	35	uint16	1	16
SUBTOTAL		**36**	**0**	**35**			
Additional XWAV Header							
HARP Chunk	hSubchunkID	4	36	39	uchar	4	"harp"
	hSubchunkSize	4	40	43	uint32	1	56+30*32
	WavVersionNumber	1	44	44	uchar	1	0
	FirmwareVersionNumber	10	45	54	uchar	10	1.xxxyyyzz
	InstrumentID	4	55	58	uchar	4	"01 "
	SiteName	4	59	62	uchar	4	"ABCD"
	ExperimentName	8	63	70	uchar	8	"EXP12345"
	DiskSequenceNumber	1	71	71	uchar	1	1
	DiskSerialNumber	8	72	79	uchar	8	12345678
	NumOfRawFiles	2	80	81	uint16	1	1
	Longitude	4	82	85	uint32	1	-17912345
	Latitude	4	86	89	uint32	1	8912345
	Depth	2	90	91	uint16	1	5555
	Reserved	8	92	99	uchar	8	00000000
SUBTOTAL		**64**	**36**	**99**			

	Field Name *PARAMS.xhd. precedes each*	Length in Bytes	Start	End	Format	# of Elements	Example
Additional XWAV Header cont. *Repeated for each RawFile(k) n=32(k-1), usually 30*							
HARP dir Subchunks	year(k)	1	100+n	100+n	uchar	1	7
	month(k)	1	101+n	101+n	uchar	1	12
	day(k)	1	102+n	102+n	uchar	1	31
	hour(k)	1	103+n	103+n	uchar	1	23
	minute(k)	1	104+n	104+n	uchar	1	59
	secs(k)	1	105+n	105+n	uchar	1	59
	ticks(k)	2	106+n	107+n	uint16	1	999
	byte_loc(k)	4	108+n	111+n	uint32	1	1066
	byte_length(k)	4	112+n	115+n	uint32	1	30000000
	write_length(k)	4	116+n	119+n	uint32	1	60000
	sample_rate(k)	4	120+n	123+n	uint32	1	200000
	gain(k)	1	124+n	124+n	uint8	1	1
	padding	7	125+n	131+n	uchar	7	0000000
SUBTOTAL		**32+n**	**100**	**131+n**			
Data Chunk							
Data Chunk	dSubchunkID	4	132+n	135+n	uchar	4	“data”
	dSubchunkSize	4	136+n	137+n	uint32	1	datasize
	DATA		138+n				

For additional information see comments in rdxwavhd.m, wrxwavhd.m, and initdata.m in Triton.

For typical full HARP XWAV files, file size will be 900,001,068 bytes or 30 raw files (n) 30,000,000 bytes/rawfiles & 1068 byte header.

Appendix A3- Software Routines (*.m files)

Name	Description
audvidplayer	Play sound of DATA vector (ie plotted data only)
bin2xwav	Convert *.bin (ARP binary) files into *.x.wav files
calc_ltsa	Calculate spectral averages and save to ltsa file
check_dirlist_times	Get recording parameters and run difftime_dirlist for one file or whole directory
check_ltsa_time	Check to see if plot time is within file limits
check_time	Check time of start of plot based on PARAMS.plot.dvec time
ck_ltsaparams	Check user defined ltsa parameters and adjusts/gives suggestions of better parameters so that there is integer number of averages per xwav file, called by mk_ltsa.
control	Toggle on/off control window pull-down menus and buttons set and implement newtime, newtseg, newstep, coordinate display
control_ltsa	Toggle on/off control window pull-down menus and buttons set and implement newtime, newtseg, newstep, coordinate display
coorddisp	Display cursor values from Plot window in message window
decimatexwav	Decimate XWAV file
decimatexwav_dir	Decimate all XWAV files in directory
difftime_dirlist	This function reads raw HARP files disk directory and compares times between directory entries, used for data quality checking
disp_headSummary	Display PARAMS.headall structure in useful format
disp_msg	Display messages in message window
disp_pick	Display pickxyz in message window
displaybut	Display button operation
editHeader_psds	Used to change time or other header values for psds files (not used)
editHeader_xwav	Used to change time or other header values for XWAV files
filepd	File pull-down menu options/operations
get_headers	Open data files and read headers
get_ltsadir	Get directory of WAV/XWAV files
get_ltsaparams	Get parameters needed for generating LTSA's from user
get_recordingparams	Get recording parameters needed for checking dirlist times
getIndexBin	Get time bin index in LTSA plot
helppd	Help pull-down menu
hrp2wav	Convert *.hrp files into *.wav files
hrp2xwav	Convert *.hrp files into *.x.wav files
init_coorddisp	Initializing cursor values
init_ltsadata	Initializing ltsa data stuff
init_ltsaparams	Initializing ltsa parameters
initcontrol	Initializing control window GUI
initdata	Initializing data and timing info

Continued on next page

Name	Description
initparams	Initializing parameters
initpulldowns	Generate figure pull-down menus
initwins	Initialize plot, control and command (display) windows
little2big_2byte	Reads N x 2 array (a) and converts the 2 values from each row from little endian format to big endian format – array (b)
little2big_4byte	Reads N x 4 array (a) and converts the 4 values from each row from little endian format to big endian format – array (b)
logfmap	Return a matrix for premultiplying spectrograms to map the rows into a log frequency space
make_multixwav	Script to run write_hrp2xwavs over many hrp files to make xwavs
mk_headSummary	Make Summary of header values
mk_ltsa	Make LTSAs from XWAV files in a directory
mkspecgram	Make spectrogram plot from DATA
motion	Control motion of DATA plot with push button in control window
motion_ltsa	Control motion of DATA plot with push button in control window
multibin2xwav	Convert multiple *.bin files to *.x.wav files
obs2xwav	Convert *.obs files into *.x.wav files
pickxwav	Turn on picking time in LTSA files and open corresponding xwav file (i.e. zoom in)
pickxyz	Pick x, y, z cursor data from plot window
plot_ltsa	Plot LTSA data in plot window
plot_specgram	Plot spectrogram of data in plot window
plot_spectra	Plot spectra of data in plot window
plot_timeseries	Plot time series of data in plot window
plot_triton	Checks to see which plots are to be plotted and plots them
rdxwavhd	Reads XWAV or *.wav file header
read_ltsadata	Read LTSA data
read_ltsahead	Read LTSA header and directories
read_rawHARPdata	Reads one raw HARP disk data file, ~60000 sectors the first timing header will be read and used.
read_rawHARPdir	Calls the function read_rawHARPhead to get disk header values then reads the directory list, rearranges values and puts values in global PARAMS variable
read_rawHARPhead	Read raw HARP disk header info from raw HARP datafile (*.hrp) and put disk header info into global variable structure PARAMS
read_xwavHDRfile	Hdrfile for hrp2xwavs input for generating xwavs from hrp files
readseg	Read a segment of data from opened file
timenum	Convert string time in format made from timestr.m (used to solve rounding problems created by datestr.m and outputs msecs and usecs)

Name	Description
timestr	Can be used instead of datestr.m to solve the rounding problems created by datestr.m and outputs msecs and usecs
toolpd	Tools pull-down menu operation
triton	MAIN
write_hrp2wavs	Writes multiple XWAV (*.x.wav) files(~1GB) from single raw HARP disk file (*.hrp). The HRP files are essentially images if raw disks
write_ltsahead	Setup values for ltsa file and write header & directories for new ltsa file
write_XWAVhead	Write XWAV header values to output files
wrxwavhd	Write XWAV header values to output files