

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
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| Data Acquisition System Data Viewer Reference |
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LIGO DRAFT

1 INTRODUCTION

The Data Viewer is a graphic data viewing tool which is designed for displaying data provided by the DAQS Data Server. This document is intended as a reference guide for the functionalities and usages of the Data Viewer.

The Data Viewer has two basic parts: the control panel which is user interactive and the xmgr window which displays data in various formats. Different display formats such as time sequence base or frequency base can be chosen. Up to 16 data channels can be displayed in “real-time” (on-line) or some playback modes (off-line). The following section gives a description of the operation of this tool.

2 OPERATION

2.1. Getting Started

The executable files are currently at the directory “/opt/CDS/d/epics/apple/Caltech/FRAME/release/New1/”. User may create his own working directory and copy the following files to it: “dataviewer”, “dc2”, “framer3”, “frameMemRead”, “xmgr”, and “.leapsecs.dat”. The last file reflects the current adjustment of the leap seconds which needs to be updated whenever new leap second occurs.

2.1.1. Starting the Data Viewer Control

From the working window (which will be the message window as well), go to the working directory, then type “./dataviewer -s <Data Server IP Address>”, e.g., “./dc2 -s 131.215.115.67”. This will cause the data viewer control panel (Figure 1) to be displayed on the screen.

Besides the option “-s” which specifies the data server IP address, there are also a few more options for starting the control panel. For instance, “-l <User’s listening Port Number>” should be used while multiple copies of dataviewer running on the same machine -- each copy should use different listening port number (the default is 7000). Another often used option is “-x”, which allows user to start the xmgr display window on a different screen. Typing “./dataviewer -h” will give the complete option list.

2.1.2. Starting the Xmgr Display Window

On the control panel, select the “Main” menu (item 16 of Figure 1). This is a pull down menu. Select the first menu item “Start”. This will initialize the display control software and bring the display of xmgr on the screen.

2.1.3. Starting the Data Display

Now, selecting “Realtime” from the “Display Mode” panel (item 9 of Figure 1) will start real-time data display on the xmgr window with default settings. There are 16 channels set by default, with number 1 at the lower left and number 16 at the upper right. The channel number and signal identifiers are shown above each graph. In addition, the larger area at the top left of the display shows

the current selected channel (channel 1 by default) with the time of the last frame shown above the graph (Figure 5).

By the default setting, some plots may look blank, which means y-axis setting needed to be adjusted. This topic will be stated in later section 2.3.2.

2.1.4. Quit/Exit

Selecting “Quit Display” from the pull-down menu “Main” (item 16 of Figure 1) will set the xmgr window free from the data viewer control. The xmgr may be closed in the same manner of closing a X-term. A new xmgr display can be started by selecting “Start” again (see 2.1.2.), and all basic setting from the previous display will be restored automatically.

Selecting “Exit” from “Main” menu will exit the data viewer program.

2.2. Signal Selection

The data viewer takes the first 16 channels supplied by the data server as its default channels. However, you may choose any available signal from the data server and set it to a particular channel. Note that the data viewer can only handle up to 16 channels at the same time and no signal should appear more than once among them.

To see the list of channels and signals the data viewer uses currently, get the signal selection panel (Figure 2) by clicking “Sig Select” on the main control (item 11 of Figure 1). On the left side of this panel, it shows the channel number, signal name, and data rate for each channel (item 1, Figure 2). All the available signals from the data server are listed under different groups whose names are shown under the Group Names (item 2 of Figure 2). Clicking any of these group names, you can see all the signals within the group being listed under the Signal Names (item 3 of Figure 2).

To set a signal to a particular channel, type the channel number you want to set into the “New Signal Selected for Ch.” text field which is on the signal selection panel as item 4 of Figure 2. Make the selection of the signal name from the “Group Names” and “Signal Names” (item 2 and 3). The selected signal name should appear at the field of item 5. Click “Select” to make the change or “Cancel” to cancel the selection panel.

All channels can also be changed at once by selecting “Restore Setup” from “Main” menu (item 16 of Figure 1) if there is a pre-saved file (see 2.3.3.).

2.3. Display Setting

The X and Y-axis settings for the xmgr display can be adjusted from corresponding pull-down menus or text fields. **Note:** all text fields on the control with lighter color accept hand typing (an “Enter” must be typed after each entry); entries at the fields with darker color can only be changed by using the corresponding pull-down menu(s).

2.3.1. Adjust X-Axis Settings

There are two types of X-axis adjustments. If x-axis is in time sequence display (in seconds), make a selection of 1, 2, 4, 8, or 16 from the pull-down menu “X Axis” on the top panel (item 13 of Figure 1). If x-axis is in frequency display (in Hertz), it should be adjusted by typing numbers in the “Min” (item 21) and “Max” (item 22) text fields on the control panel. The acceptable frequency range is from 0 to 8192.

Any X-axis adjustment affects *all* channels.

2.3.2. Adjust Y-Axis Settings

Y-axis and Y-offset are adjustable for *each* channel while in time sequence display. First select the desired channel number from the “Chan. Select” panel (item 2 of Figure 1).

To adjust the y-axis range for the selected channel, open the “Y Axis” menu (item 14) and select the desired scale from the submenu selections. The Y-axis can also be entered manually by moving the cursor into the Y Axis field (item 5) and typing in a setting (must type “Enter” after typing a number in the field).

To adjust the Y-axis offset for the selected channel, make a selection from the “Y Offset” menu (item 15) or enter a value in the Y Axis Offset field (item 6).

Y-axis adjustment affects *all* channels for spectrum display.

2.3.3. Save/Restore Settings

Once all settings are setup as desired, they can be saved in a file for later recalls. To save, open “Main” menu (item 16 of Figure 1) and select “Save Setup”. A file selection window will pop up. Choose a file for saving (you may choose an existing file or type in a new name) and click “OK”. Whenever it may be desired to recall these settings, simply select “Restore Setup” from the “Main”, select the file name, and click “OK”.

2.3.4. Auto Setting

The first item under the pull-down menu “Y Axis” (item 14) is “AUTO”. By selecting “AUTO”, xmgr will automatically set the proper display Y-range and Y-offset for the selected channel. However it is not recommended to use auto setting for general display since it may slow down the display. Auto setting should be used only for locating the curve, and then y-axis and y-offset should be set manually by the methods mentioned in 2.3.2.. Do not use “AUTO” for more than two channels at the same time.

2.4. Display Mode

The data viewer has capability to display data in real-time or in various playback mode. The following choices are available from the “Display Mode” panel (item 9 of Figure 1).

2.4.1. Stop

While in “Stop”, the data viewer stops requesting data from the data server. The xmgr display is in an interactive mode. It shows the last graph displayed on the screen and all menus and buttons on the xmgr window become available. For the usage of xmgr, see Xmgr User Guide at “<http://plasma-gate.weizmann.ac.il/Xmgr/doc/xmgr.html>”.

2.4.2. Realtime Display

By selecting “Realtime”, the data will be displayed in a real-time manner (may have a 1 to 2 second delay from the time it is actually acquired). It is in general updated once per second; and for certain cases it could be updated up to 16 times per second (see later section 2.7.3. “Refresh Rate” for more on this topic) .

2.4.3. Data Playback

Along with realtime data display, data stored by the Data Server may also be recalled for presentation in xmgr. There are approximately 8 hours of full data and 30 days of trend data available.

2.4.3.1 Time setting for playback

Reference time: this is the time for starting (PlayFwd) or ending (PlayBack) the display. To set it, enter the year, month, day, hour, minute, and second into the fields under “Time Settings for Playback Modes” which shown in Figure 1, item 26. To quickly set all fields to the last displayed time, simply click the button “TimeNow”(item 28).

Display period: it is the length of time period for playback. Enter the hour, minute, and second into the fields of the second line(item 27).

Note: make sure to press “Enter” after each entry.

2.4.3.2 PlayFwd

By selecting “PlayFwd” from the Display Mode panel, the xmgr will display data starting from the reference time. It will last for the length of the display period, with refreshing for each second increment. As an example, using the values setup shown in Figure 1, it will display data from 14:55:05 until 15:10:04

2.4.3.3 PlayBack

Different from the “PlayFwd” mode, the reference time for “PlayBack” mode is the time to end the display instead of starting the display. Using the settings in Figure 1, the display will start at 14:40:05 and end at 14:55:04, refreshing for each second increment.

2.4.3.4 Long Playback

The time setting is as same as for “PlayBack” mode. Unlike the above two playback mode, “Long Playback” will produce a new xmgr window and display all information during the given display period at once. It will not display any information until all of the data from the selected period has been read (you may have to wait for a while). Full data will be displayed if the length of the display period is less than or equal to 10 seconds. Otherwise it will display second-trend or minute-

trend data if the display period is less than or more than 60 minutes respectively. The limit for display period is currently set to 360 hours (15 days).

2.5. Display Option

Display options give user different ways to display and observe data, such as time domain, frequency domain, history and some two-channel features. The choices can be made from the “Display Option” panel (item 8, Figure 1).

2.5.1. TimeBase

By selecting “TimeBase”, the xmgr will display data in time domain. The X-axis shows time in seconds and Y-axis is in ADC counts. Up to 16 seconds of data for each channel can be displayed. By default, the X-axis is 8 seconds and Y-axis is +/- 4000 counts.

2.5.2. Spectrum

By selecting “Spectrum”, the selected channel will be shown as power spectrum over a period of 1 second. The X-axis is in Hertz and the maximum range may be set from 0 to 8192 (the default is 0 to 1000). “Spectrum/win” selection will display spectrum with a data windowing (Welch).

2.5.3. Trend

Trend data can be viewed in real-time or over a selected time period by PlayFwd/PlayBack. “Trend.max”, “Trend.min”, or “Trend.rms” shows maximum, minimum, or RMS value for each channel respectively; “Trend” will display all three curves of maximum, minimum, and RMS value for each channel in the same graph.

Settings: the X-axis shows the time period (in seconds) of trend being displayed. It resets itself to zero every 12 hours (43200 seconds). While resetting, all xmgr sets will be saved automatically to a save file with the time stamp as its name. The settings of Y-axis for trend display are taken from the TimeBase settings.

2.5.4. A/B Display

“A/B Display” provides the following 2-channel analysis features: the data plots (default) and the power spectra for both channels (Spectrum A and Spectrum B), correlation of two channels (Correlation A/B), power spectrum of the time correlation (Spectrum A*B), and one channel against another (A vs B).

To choose any of these options, first click “A/B Control” button from the main control panel (item 18, Figure 1). The “A/B Display Control” window will be opened as shown in Figure 3. The signal names for the channel A and B are shown at the fields of item 1 and 2, Figure 3, and they can be changed from “Ch.A Sel.” and “Ch.B Sel.” buttons (item 3 and 4). Other options can be seen at the lower part of the panel and can be enabled/disabled by clicking the corresponding push buttons.

Settings: The settings for the time base plots and spectra are taken from the general TimeBase and Spectrum settings. The ranges of axes for the time correlation are fixed: horizontal $[-0.5, 0.5]$ and vertical $[-1, 1]$. Changing them can only be done by using mouse in the xmgr window.

2.5.5. Freq vs Time

The frequency vs Time mode demonstrates spectrum history for the selected channel. Carpet and waterfall options can be selected. To make a selection, first open “Freq vs Time Display Control” panel (shown as Figure 4) by clicking the “F. vs T. Control” button from the main control panel (item 19, Figure 1).

2.5.5.1 Carpet

The carpet mode is based on Keith Riles’s code which is modelled after Bruce Allen’s diag example program in GRASP. The carpet plot has time history as its horizontal axis with the latest time at the right. The vertical axis is in frequency. Pixels are shown for each frequency channel in which the power exceeds a certain threshold. As time progresses, the pixels move toward the left in a roll mode like that used for time series display. An example is shown in Figure 6. There are two types of thresholds described below. History shows back to the last 30 (by default), 60, 90, or 120 seconds, which can be adjusted by clicking on the choice button of item 3, Figure 4. No threshold checking is performed until 10 seconds of data have been taken.

Carpet w/Absolute Threshold: The threshold is a constant specified (in db) by a text field on the panel (item 1, Figure 4).

Carpet w/Variable Threshold: In this case, the threshold depends on both the mean value and the typical deviations seen for the channel. One may specify the threshold on a text field of the F.vsT. Control panel which is in units of “sigma” (item 2 of Figure 4). Instead of a true RMS, however, what is used here is the running average of the absolute deviation of the channel from its own running average. The averaging is done via an exponential decay time weighting (time constant = 10 seconds), similar to that used in the diag program. Ideally, the variable-threshold carpet plot should appear to be a random distribution of dots. Non-randomness, such as clustering, horizontal lines, or vertical lines, indicates transient noise sources (or signal).

2.5.5.2 Waterfall

The waterfall display shows the history of the power spectrum of the selected channel. As seen in Figure 7, the left graph shows up to 30 (by default, or you may choose less time period by clicking on the choice button of item 4, Figure 4) spectra simultaneously, corresponding to spectra observed at earlier times. The bottom curve is the most current spectrum. The one above it is the preceding one. Again, as for the carpet plot, one looks for non-random behavior to recognize transient noise or signal. The two plots at the right side show the current time series (top) and the current spectrum (bottom).

2.6. Display Method

Different display methods are provided by the data viewer to view data in different manners. They can be selected on the “Display Method” panel (item 17, Figure 1). The display methods described below don’t apply to A/B Display and Freq vs Time option.

2.6.1. Standard

While selecting “Standard”, xmgr window displays up to 17 graphs. The larger one at the upper left corner shows the plot for the selected channel and option. Other smaller graphs show up to 16 (see the topic “Total Channels” in section 2.7.1.) channels of data in time series, with channel number 1 at the lower left and increasing to the upper right.

2.6.2. Multiple

The “Multiple” method makes xmgr display up to 16 channels in the same graph. The scale shown is the scale for the selected channel, with other channels projected to it. It doesn’t apply to Trend, but does apply to Trend.max, Trend.min and Trend.rms.

2.6.3. Persistence

This selection displays the selected channel for the last 4 seconds. The curves fade away with time passing. It applies to TimeBase and Spectrum only.

2.6.4. Stack

Similar to the Persistence method, the “Stack” selection also displays the selected channel for the last 4 seconds and it applies to TimeBase and Spectrum only. Instead of fading away, here the curves shift toward the upper right with time passing.

2.7. Other Display Options

This section describes some of other additional features which are available on the data viewer.

2.7.1. Total Channels

While selecting “Standard” or “Multiple” graphic methods, the number of the channels to be displayed is adjustable (up to 16). To do so, open the “Display” pull-down menu (item 12, Figure 1) from the main control, go to the submenu “Total No. of Channels”, and select a number from there. The number is shown at the “Total Channels” field as item 23 of Figure 1. This number applies to the Long Playback as well.

2.7.2. Resolution

In general, the resolution for the time series display is 128 per second (if the rate of the signal is larger than or equal to 128 Hertz) or less (full data will be displayed if the rate of the signal is less than 128 Hertz). The data viewer allows user to choose different resolution for the selected chan-

nel on TimeBase/Standard display. When the Display Option (item 8) is “TimeBase” and the Display Method (item 17) is “Standard”, the number shown at the Resolution field (item 24, Figure 1) reflects the resolution of the data plot of the current selected channel, which is the larger graph at the upper left of xmgr. To adjust this number, open the “Display” pull-down menu (item 12, Figure 1) from the main control, go to the submenu “Resolution”, and select a number from there. Note that the resolution is always a power of 2, and it should be less than the rate of the current selected channel. If the rate of the selected channel is less than the chosen resolution, the display will be automatically stopped and an error message will be shown at the message window. (for the topic of Message Window, see section 3.1).

To get the rate of a channel/signal, open the Signal Selection window by clicking the button “Sig Select” on the main control (item 11, Figure 1). The rates are shown next to the signal names.

2.7.3. Refresh Rate

The general refresh rate of graphing for the data viewer is once per second. However, for the Standard or Multiple time series data display (TimeBase), the refresh rate can be set up to 16 times per second. The rate is shown at the Refresh Rate field as item 25 of Figure 1. To adjust this number, open the “Display” pull-down menu (item 12, Figure 1) from the main control, go to the submenu “Refresh Rate”, and make a selection from there (1, 2, 4, 6, 8, or 16). The refresh rate is ignored unless the Display Option (item 8) is “TimeBase” and the Display Method (item 17) is either “Standard” or “Multiple”.

Note: the xmgr display may not be able to catch up the speed with high refresh rate. In this case, reducing the total channel number may help some.

2.7.4. Y Scale Type

The scale of the Y-axis of the display for each channel can be chosen in one of the following three types: Linear, Log, or Ln. The default is Linear. To change Y scale type for a particular channel, first select the channel number from the Chan. Select panel (item 2, Figure 1), then open the pull down menu “Y Axis” (item 14) and select the scale type from the submenu “Y Scale Type”. The selected scale type is shown at the Y Scale Type text field (item 7).

2.7.5. Color Selection

Under the “Color Selection” menu (item 20, Figure 1), there are six choices available: Green, White, Red, Blue, Yellow, and Multiple. The selected color is used for “Persistence” or “Stack” display, as well as the “A/B display” and “Freq vs Time” mode. The Multiple color selection is used only for “Freq vs Time”/“Waterfall” case, in which the curves are displayed in different colors (see Figure 7), or a default color green will be used for other cases.

2.8. Trigger

A simple trigger control is available on the data viewer. It is located at the lower right corner of the main control panel. It is used for triggering (*i.e.*, freezing the scrolling of plots at the xmgr window) when certain conditions are satisfied.

Set trigger signal: the name of the trigger signal is shown at the Trigger Signal Name field (item 29, Figure 1). To set the desired signal as a trigger signal, first find out the channel number of the signal. To do so, look at the Signal Selection Control or you may set the signal to a particular channel number (see 2.2. Signal Selection for instructions). Then set this channel for trigger by selecting the channel number from the pull-down menu “Sig. Sel” (item 30, Figure 1).

Set trigger definition: you may choose “Any Value”, “Mean Value”, or “RMS Value” from the menu of item 31, and choose “Above” or “Below” from the menu of item 32. The trigger level should be hand typed in the text field of item 33 (type “Enter” after typing in the number!).

Enable/disable trigger: click the “Trigger Control On” indicator (item 34) to enable or disable the trigger control.

As the example shown in Figure 1, the trigger definition is “*Any Value is Above the Trigger Level 1000.0 ADC Units*”. Therefore the trigger will take effect whenever the trigger signal exceeds 1000 adc units. To resume the graph plotting after it is triggered, simply click “Realtime” under the “Display Mode” (item 9, Figure 1).

3 MESSAGE WINDOW

The message window is the terminal window where the data viewer control is started. The data viewer shows its status report and debugging information such as the general display information, user’s selections, warning and error messages on the message window. While data being displayed, it shows the time stamp of the data and indicates any block drop as well. You can monitor the behavior of data display through the message window.

3.1. Status Report

The data viewer reports its status on the message window whenever there is an action taking place. The following describes some of most often used messages.

Message queue: The data viewer control uses message queue to communicate with the data display tool. When user makes a selection from the control panel, a line

“messg received *****”

will be shown on the message window.

Data time stamp: While data being displayed, either in real-time or playback mode, the time stamp of the data will be displayed on the message window, *e.g.*,

“data read: 98-11-20-19-10-40”.

Data transmit for playback: While requesting data playback, the starting time and the display period are shown on the message window, *e.g.*,

“DataWrite ID=30950856 starttime=98-11-20-19-10-38(595627850) duration=5”.

The line

“trailer received”

indicates the transmission is completed.

3.2. Warning/Error Message

Warning and Error messages are shown on the message window. It is advised to check the messages whenever you experience something ‘weird’.

Ignore: Sometimes you may see a message saying

“Server error 12: no such net-writer”

which can be ignored. It comes from the data server and indicates the process has already been stopped.

Block drop: Any data block drop is indicated on the screen, *e.g.*,

“!!data dropped 12 blocks”.

It happens usually when the xmgr display does not catch up the speed.

4 TROUBLESHOOTING

A quick reference and troubleshooting for the data viewer is currently located at

“<http://www.ligo.caltech.edu/~hding/Viewer/Help/>”

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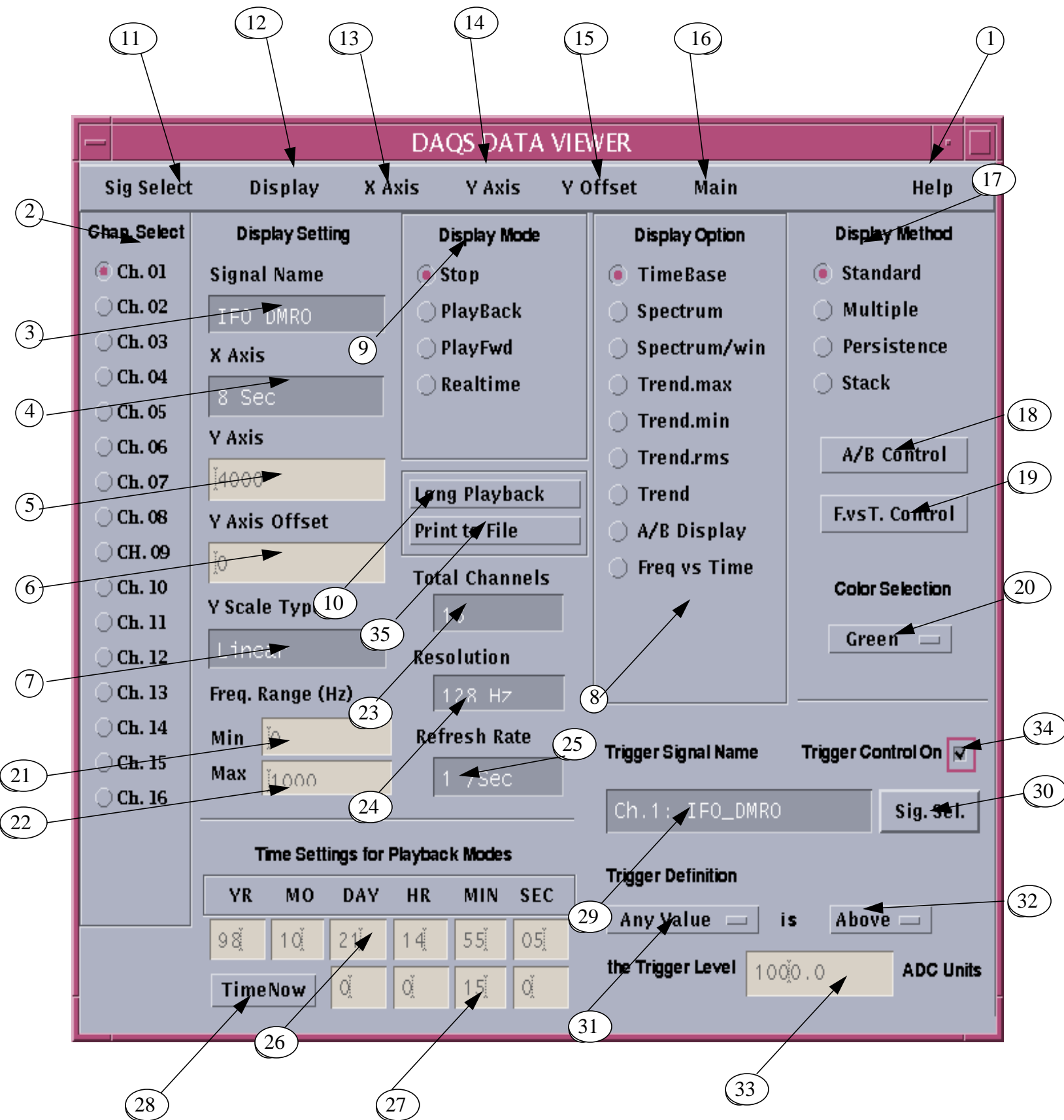


Figure 1: Data Viewer Control Panel

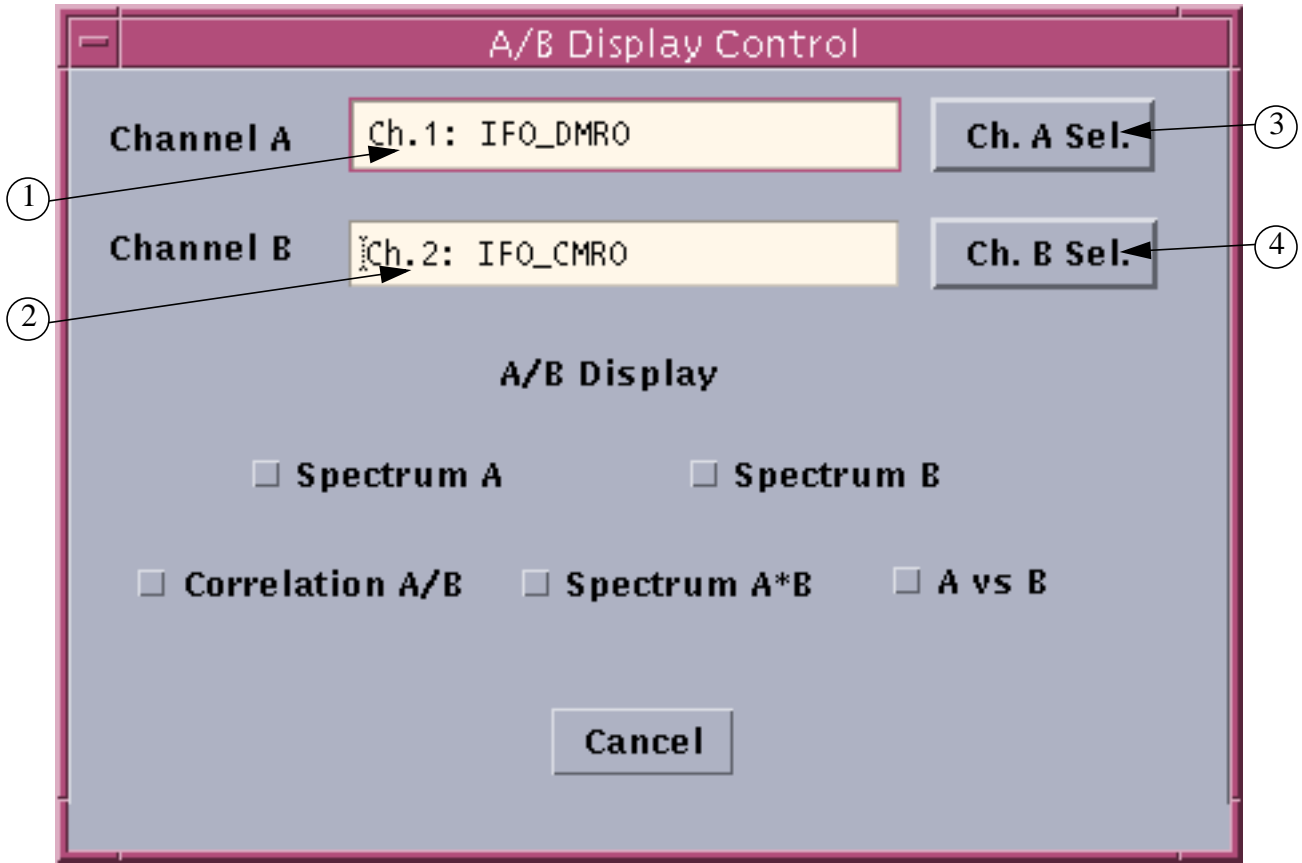


Figure 3: A/B Display Control Panel

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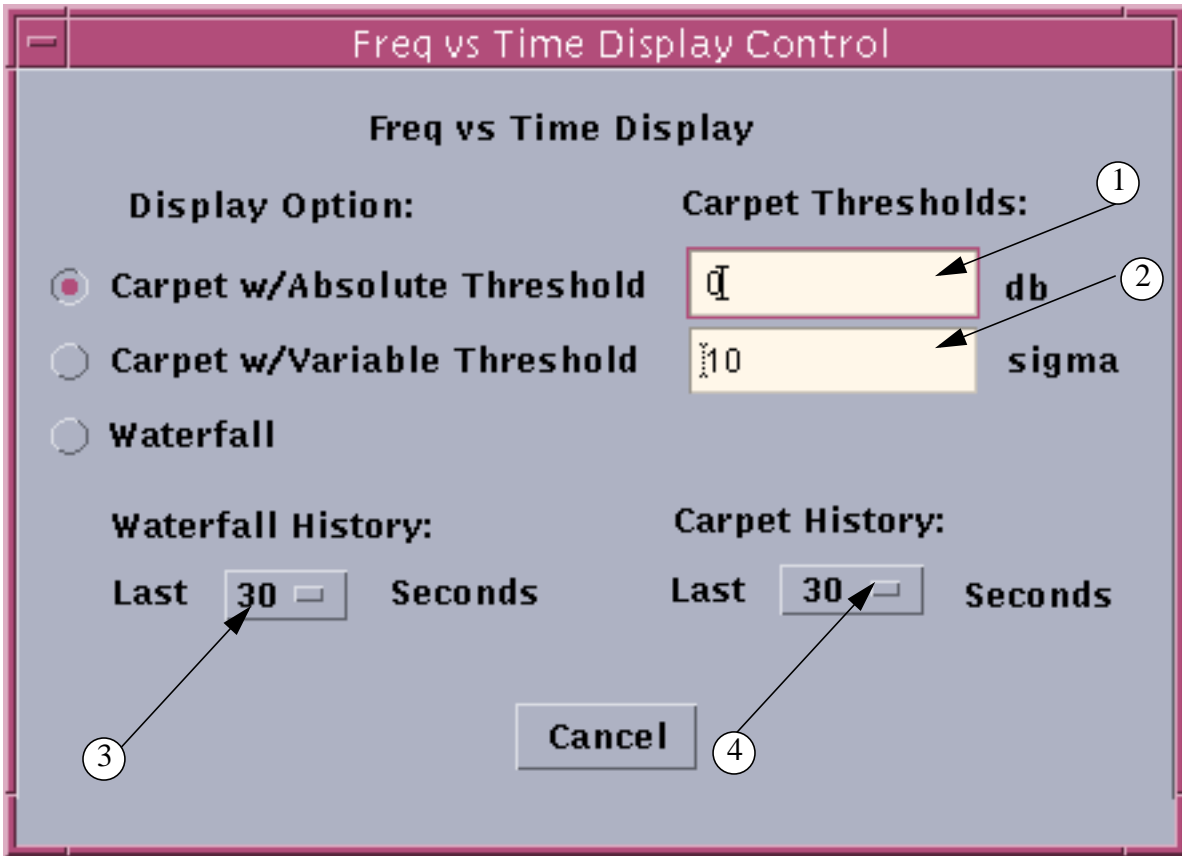


Figure 4: Freq. vs Time Display Control Panel

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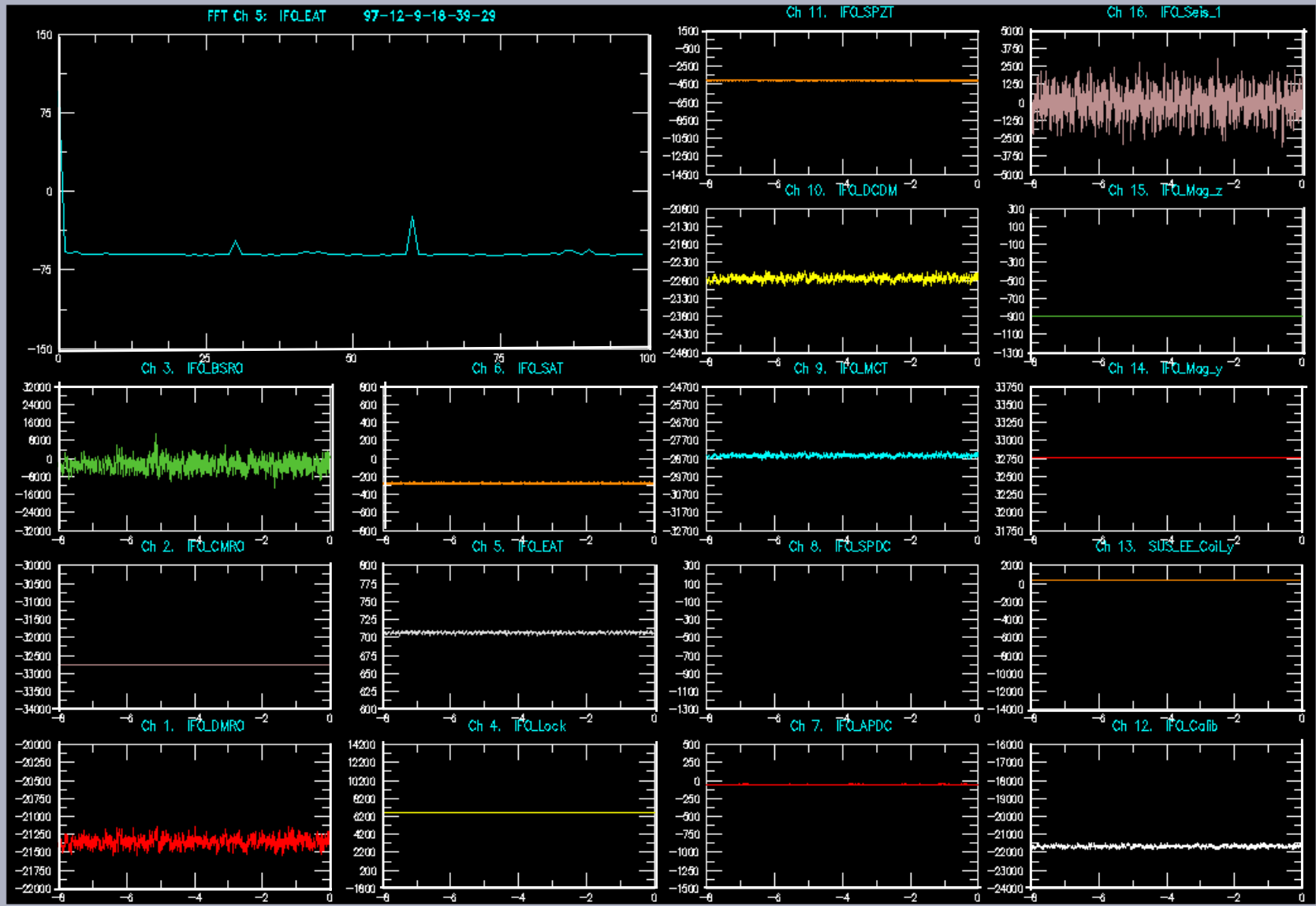


Figure 5: Xmgr Display - Standard

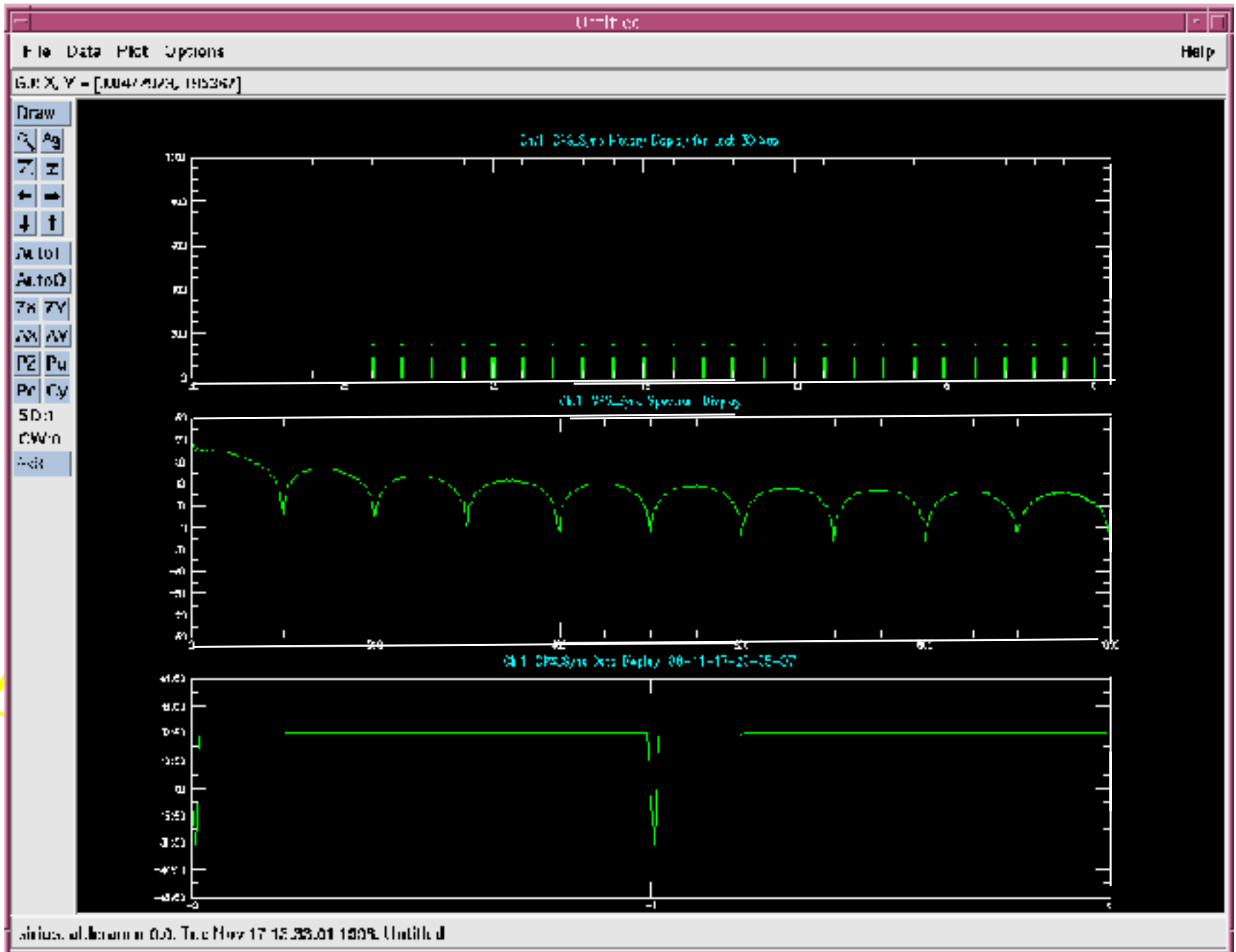


Figure 6: Xmgr Display - Carpet

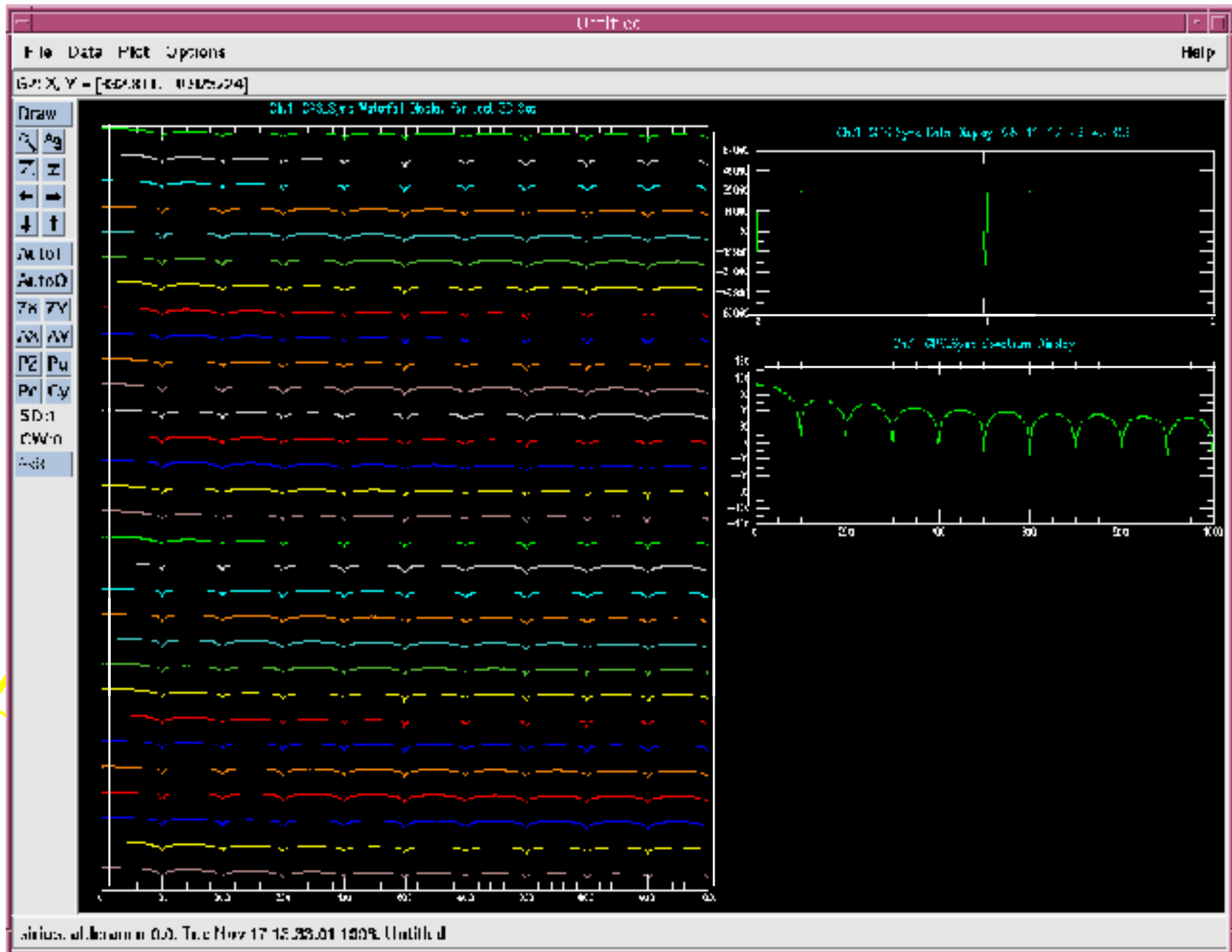


Figure 7: Xmgr Display - Waterfall