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40m Data Acquisition System Quick Reference

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1 INTRODUCTION

This document is intended as a quick reference quide for startup and operation of the CDS data acquisition system (DAQS) prototype installed at the Caltech 40m Lab.

2 SYSTEM OVERVIEW

A system sketch is shown in Figure 5 at the back of this document. The main components are:

1. South Vertex Equipment Rack: Houses the DAQS VME crate and anti-aliasing filter chassis. The system has ADC interfaces for 32 fast channels (16KHz sample rate/ 16 bit resolution) and 128 slow channels (16Hz sample rate / 12 bit resolution). Data is read out of the ADC modules by the left most Baja4700 MIPS processor in the VME crate and transferred via reflected memory to the processor in the right half of the VME crate. This second processor formats the data into standard LIGO/VIRGO frames and transmits it to the DAQS server, via a private fast ethernet, for storage to disk.
2. Control Area Rack: This rack houses the DAQS server, 38GByte storage array, and the 10 tape/dual drive tape robot system. The DAQS server is a dual UltraSparc 200MHz CPU unit with 128MBytes of RAM.
3. Operator Console: This is a three bay rack console system. The left most display in this console, along with keyboard and mouse, connects to the DAQS server housed in the Control Area Rack. The right two monitors connect to another sparcstation mounted in the bottom of the center console. This sparcstation is again a dual UltraSparc 200MHz unit with 512MBytes of RAM. This is the computer which runs all of the DAQS user interfaces.

3 SYSTEM OPERATION

Typically, the 40m DAQ system is in operation at all times, continuously recording data to disk (last 10 hours). This section describes operation of the system under these conditions. Should the system need to be restarted, see Section 4.

3.1. Data Acquisition

3.1.1. Normal Operation

As previously mentioned, the DAQS is typically always acquiring data and writing it to disk. To determine if the DAQS is running properly, take a look at the Main Control Panel (shown in Figure 1: Main Control Panel). This panel is usually active on the center screen of the operator console. If not, check the various window icons to see if it has been iconized.

On this display, the status of the acquisition processors is shown as DCU Status and FB Status (fields 4 &5 of Figure 1: Main Control Panel). These fields should display “Acquiring” and the Frame Count and Accum. time (fields 6 & 8) should be incrementing. “Last File” (field 9) indicates the name of the last frame file written in the form of “C1_year_month_day_hour_min_sec” and should also be updating every second.

3.1.2. Abnormal Indications

The most common indications that the DAQS is not acquiring data are:

1. All data entry and display fields on the DAQS control panel appear as white blanks. This indicates no communication with the VME processors which are acquiring data. In this event, the DAQS is not functioning and needs to be rebooted (See section 4).
2. The “DCU Status” and “FB Status” fields of the display both indicate “IDLE”. This indicates that the system is ready to run, but has not been started or has been manually stopped for some reason. To start acquistion, simply click on the “START” button (item 1 of Figure 1). This should restart the system, with both processor status fields going to “Acquiring”.
3. The “DCU Status” field indicates “IDLE”, the “FB Status” field indicates “No Config” and the “Last File” (field 9) indicates “System Not Configured!!”. This indicates that the system is powered on, but is not yet configured to run. In this case, click on the “Config” button (item 2 of Figure 1). The text of field 9 should now indicate “System Being Configured”. After ~30 seconds, the FB Status should indicate “IDLE”. The system is now ready to run as in item 2 above.
4. The processor status fields (4&5) indicate “Acquiring”, but the frame count and accum. time are not incrementing at 1 sec intervals. This is another indication that the acquisition processors are not functioning properly and the system needs to be rebooted as described in section 4.

3.2. Data Display

Along with acquiring data, the 40m DAQS prototype has limited capability to display data. This data is presented in “real-time”, or in various playback modes.

Data is displayed through the use of xmgr as shown in Figure 3. It is set up to show up to 16 data graphs, number 1 at the lower left to number 16 in the upper right. The display channel number and signal identifier are shown above each graph. In addition, whatever signal is selected is displayed in a larger area in the top left of the display, with the time of the last frame shown above the graph. Figure 2 shows the display panel which is used to control the display of data in xmgr.

3.2.1. Startup

The display of figure 2 is typically always running on the center screen of the DAQS console, with the xmgr display on the right most console screen. If they are not, first make sure that they have not been iconized. If they are found to not be running:

1. Open a terminal on the center screen of the console.
2. “cd” to the sun software directory, presently “/opt/CDS/d/epics/apple/Caltech/FRAME/release/”.
3. Setup the necessary environments by entering “setup epics/release/r3.12”.
4. Enter “startDisplay”. This will cause the display control panel (Figure 2) to display on the center console screen.
5. On the display control panel, select the “Main” menu (item 1 of Figure 2). This is a pull down menu, the first item of which is “Start”. Select this menu item. This will initialize the display control software, bringing the display of xmgr on the right screen, setting the channel select to

Ch. 01, Display Mode to STOP, Graph Method to TimeBase, and set in the first 16 fast data signals to be viewed. The signal information for Ch. 01 will be displayed (Signal Name, Display Frequency, X Axis, Y Axis, and Y axis offset).

3.2.2. Display Frequency

The display frequency controls how often the data being updated. The choices of 1, 2, 4, 8, or 16 Hurtz are available. The default is set to 1 Hz. To change display frequency, click on the pull-down menu “Display” (item 12 of Figure 2) and select the desired number from the submenu “Display Frequency”. The display frequency will be shown at the Display Frequency field (item 7, Figure 2). If the xmgr display gets too slow, you may want to choose less frequency or choose less number of channels (see Window Number below) for display.

3.2.3. Window Number

The Window Number is the number of channels for the xmgr display. The maximum Window Number (default) is 16. To change Window Number, click on the pull-down menu “Display” (item 12 of Figure 2) and select a number from the submenu “Window Number”.

3.2.4. Viewing “Realtime” Data

Up to sixteen channels can be viewed in “realtime” on the xmgr display. This data is updated according to the display frequency (up to 16 Hertz) with ~ a 1-2 second delay from the time it was actually acquired. Different graphic methods can be chosen to view the data (see 3.2.6. below for details). To view realtime data:

1. Select “REALTIME” from the “Display Mode” (item 3 of Figure 2) area of the display control panel. On startup, the software automatically selects the first 16 fast (16KHz) data channels for display and these will appear in the xmgr plots. The name of the signal being plotted in each graph will appear above each graph with the display channel number.
2. To change the signal being sent to a particular xmgr plot, select the desired plot/channel number from the Chan. Select radio button (item 2 of Figure 2). As each is selected, the signal name, display frenquency, and graph axis information will be displayed in items 6 through 10 of figure 2. Next, open the “Sig Select” menu (item 11 of Figure 2) and select the desired signal from the submenu choices. When selected, the new signal name will appear in the “Signal Name” field (item 6) and the new signal will appear in the appropriate xmgr graph area.
3. The Y axis is selectable from the Y axis menu. To set the axis, first select the desired channel from the Chan. Select (item 2). Then 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 9) and typing in a setting (must type **Enter** after typing a number in the field).
4. The Y axis offset is also adjustable. Again, select the desired channel and then make a selection from the Y Offset Menu or enter a value in the Y Axis Offset field (item 10).
5. To adjust the setting for the X axis , select the desired channel , open the X Axis menu (item 13 of Figure 2), and make a selection from the menu. Note that unlike the Y axis, the X axis can not be changed by typing a setting in the X axis field.
6. Once the xmgr plots for the TimeBase are setup as desired, this setup can be saved to file for later recall. To do this, open the Main menu and select “Save Setup”. A file selection window

will pop up. Choose a file for saving and click “OK”.Whenever it may be desired to recall these settings, simply select “Restore Setup” from the main menu and follow the same procedure above.

7. Selecting “Quit” from the “Main” menu (item 1 of Figure 2) will set xmgr in an interactive mode. The xmgr display will be independent from the control panel and all of the xmgr menu and buttons become available. A new xmgr display may be started by selecting “Start” from the “Main” menu as described in 3.2.1.5.

3.2.5. Data Playback Modes

Along with realtime data display, data may also be recalled from the DAQS disk array (about last 7 hours) for presentation in xmgr. Data playback from tape is not yet supported by the DAQS.

There are three playback modes provided:

- Playback from a set time, with the data displayed in xmgr in the same fashion as the realtime mode, i.e. up to 16 seconds of data updated at the display frequency (up to 16 Hertz).
- Play forward from a set time. This displays data in the same manner as the playback mode above.
- Long Playback, which starts a new xmgr window. In this mode, all the data for each channel for a selected time period is displayed e.g. if the user requests that a 30 minute time data be displayed, each of the 16 graphs will display a full 30 minutes of data for the given signal. The new xmgr window will also go to the xmgr interactive mode (all of the xmgr menus and buttons available) after the graphs are drawn.

3.2.5.1 Playback Operation

This section describes how to start the single frame playback mode, the first mode listed in the previous paragraph.

1. First, the playback start time must be selected. This is done by entering the second, hour, minute, day, month and year into the fields shown in Figure 2, item 16 (press **Enter** after each entry!). To quickly set all fields to the present time, the TimeNow (item 20) can be selected.
2. Select the time period to be displayed by entering hours, minutes and seconds into the fields of item 17, Figure 2.
3. Select “Playback >” from the Display Mode panel (item 3, Figure 2). The xmgr display will now start updating data, starting at the playback start time set in step 1 minus the playback time duration set in step 2. As an example, using the values setup as shown in Figure 2, when the Playback button is selected, the software will begin by reading the frame from 14:40:05 and continue reading and displaying data from incremental frames until 14:55:04. The xmgr display appears the same as if data were being displayed in realtime.

3.2.5.2 Play Forward Operation

This mode is setup using the same first two steps of playback mode, except select PlayFwd from the Display Mode area. In this mode, using the examples of the settings in Figure 2, the xmgr display would be updated with data starting at 14:55:05 and continue incrementing at one second intervals until the frame from 15:10:04 is reached.

3.2.5.3 Long Playback Mode

Again, this playback mode is setup the same as the others, with a start time and playback duration. Once these are set, select the Long Playback button (item 21 of figure 2). While the other two playback modes make use of the same xmgr window as the realtime mode, this mode will start a new xmgr window and graph in TimeBase or Trend for all 16 graphs (even when different window numbers are selected). This new xmgr window will not display any information until all of the data from the selected time period has been read. After that, all graphs will be plotted and the xmgr window will become interactive. To use that xmgr window, see the xmgr user's guide.

NOTE: *At the present time, data frames can be read ~5 times faster than they are written in realtime i.e. 5 seconds of data can be retrieved/second. This is not particularly fast and the long playback screen can take some time to finish. Therefore be aware that each hour's worth of data requested will take ~10-15 minutes to load and display.*

3.2.6. Graphic Methods For Display

Six choices are available on the Graph Method panel (item 4, Figure 2) to display data channels: "TimeBase", "FFT/PSD", "FFT/Window", "Correlation", "XY", ans "Trend". The default is set to "TimeBase". When one of the first five choices is selected, the large area in the top left of the display shows the selected data channel(s) under the selected method while other plotting areas show graphs in theTimeBase. When "Trend" is selected, all the plotting areas show trend data. The adjustments for the X and Y axis are recorded seperately for each graphic method. These adjustments will affect all channels in general; except in the case of "TimeBase", "XY", or "Trend" while the Y axis is selected for each channel. Note that the display frequency is selectable only for "TimeBase", it is set to 1 Hz automatically for other graphic methods.

3.2.6.1 Viewing data in time domain

To view a data channel in the time domain, select"TimeBase" on the panel. The X axis will show time in seconds and Y axis will be in ADC counts. Up to the last 16 seconds of data is plotted in each graph. By default, the X axis is 8 seconds and the Y axis is +/- 4000 counts.

3.2.6.2 Viewing data in frequency domain

By selecting "FFT/PSD" or "FFT/Window", the selected data channel is displayed as power spectrum (PSD) in terms of frequency over a period of 1 second. The unit in X axis is Hertz and the default is set to 8000 Hz. The difference between "FFT/PSD" and "FFT/Window" is that the second one is with data windowing.

3.2.6.3 Viewing correlation of two data channels

To view the display of the correlation of two data channels, first select "Correlation" option from the Graph Method panel. Select the first channel of the correlation from the Channel Selection panel (item 2). The second channel of the correlation may be selected by choosing the desired channel number from the Second Channel Selection menu (item 19) or typing the number in the second selected channel field (item 18). The correlation is done over the period of 1 second. The lag ranges from -8000 to 8000 (in 1/16384 second).

3.2.6.4 Viewing data against another data channel

A data channel (Y-channel) may be viewed against another channel (X-channel) over the same time period as in "TimeBase" mode. To do so, select "XY" from the Graph Method panel (item 4), select the Y-channel from the Channel Selection panel (item 2), and select the X-channel from the Second Channel Selection menu (item 19). The setting of the Y axis for the display is as same as the setting for the Y-channel in "TimeBase".

3.2.6.5 Trend Data

Trend data (min, max, and r.m.s. value) can be viewed in real time or over a selected time period as in other graphic methods. This is simply done by selecting "Trend" from the Graph Method panel (item 4). The setting for the X and Y axis will be as same as in TimeBase.

3.3. Tape Control

3.3.1. Operation

While data is continuously written to disk, data writing to tape is normally only done for a "data run", i.e. data is to be used for off-line analysis. The 40m DAQS provides a dual drive, 10 tape robot system for this purpose.

The right hand side of the DAQS control panel of figure 1 provides the user interface to control the tape system. To start data taking to tape:

1. Ensure that the DAQS is operational and acquiring data, as described in section 2.1.
2. Verify the tape status. Item 14 and 15 of Figure 1 show the tape and tape drive status. While this is normally updated automatically by the DAQS software, this info is presently lost if the DAQS is rebooted or tapes are manually inserted or removed from the robot. Within the Tape Status box are shown 10 blocks which correspond to the 10 tape slots within the robot. Look through the glass front panel and ensure that there are tapes in the slots indicated. Within the robot, slots are numbered from bottom to top. The bottom slot is slot 0 and is not used to hold an acquisition tape. If not, or the user opts to add/remove tapes, see step 4.
3. Verify the drive status. Item 15 of figure 1 shows the two drives. The indicator to the right should indicate green if there is a tape loaded in the drive. This indicator is black if the drive is empty. Sitting atop the SUN Enterprise 2 computer within the DAQS rack to the right of the operator console are two LCD display which indicate drive status. Check these displays and verify that they compare with the drive status indicators on the control screen. There is also a green indicator on the display of Figure 1 to the left of one of the two tape drive symbols. This only indicates which drive the DAQS will/is presently writing data to.
4. At present, the DAQS software can only keep track of the tape system through initial, manually entered information. If steps 2 and 3 show that the status on the computer screen is not the same as the physical tape drive indicates, the user needs to update the correct information. The same must be done if tapes are added or removed. This is done by:
   - Selecting the icon directly beneath the "Tape Status" text on the screen. This menu will open to "Tape Config". Selecting this will bring up the display of Figure 4.
   - There are ten radio buttons (one for each tape robot slot) on this screen. Use each radio button to indicate the tape status of these slots. (---- means Empty).

- There are two toggle buttons for setting the status of tape drives. Select either Empty or Full.
- The last toggle button is for selecting the drive that data is to be written to. This need not be set unless the user has a preferrence.
- Verify that the main control screen of Figure 1 now indicates the correct status and close the Tape Config display.

5. Select ON on the Tape Write ON/OFF button. Data will now be written to tape once an hour for the previous hour of data written to disk. The indicator below the Tape Write ON/OFF button should go to green. Selecting OFF will stop the tape operation.

3.3.2. Additional Status and Control

Other features of the tape control panel, numbered in correspondence with the numbers indicated in Figure 1 are:

11> New Tape: Depressing this button will cause the present tape to be ejected into the robot slots and a new tape to be loaded. This is to allow operators to “manually” unload tapes.

12> Flush: Selecting this button will cause all data presently on the DAQS disk drive system to be removed. This button is typically only used under special circumstances of system startup or cleanup.

13> Drive Status: Sofware is always running in the background which performs three functions:

- Write the data to tape once an hour, when tape write is activated.
- Clean data from the DAQS disk drive. Data is written in a circular buffer fashion to the disk drive, with an hour of data removed when it becomes over 10 hours old.
- Control tape swapping in the tape robot.

Status information is provided by this software as textual information in the drive status field. Messages which may appear here are:

- IDLE: Software is running and waiting for command to backup data or clean disk space.
- Backing up DIRNAME: Data is being backed up to tape from the named directory.
- Clearing DIRNAME: Data is being removed from the named disk directory.

4 DAQS STARTUP

This section describes the initial startup and fault recovery procedures for the DAQS.

4.1. VME Startup

All data acquisition and frame formatting takes place in the VME processors located in the upper most VME crate of the south vertex equipment rack. If these have been powered down or a fatal software fault has occurred (see 3.1.2. Abnormal Indications), these units must be reset. The first step in recovery is to switch the power off for the DAQS VME crate, wait ~5-10 seconds, and switch the power back on.

Once the power is restored, it will take approximately 45 seconds for the system to reboot. The fields of the main control panel of Figure 1 will all be white blanks during this period until the system is back up, at which times the data fields will again become active.

4.2. Acquisition Startup

4.2.1. Main Control Panel Not Visable

If the main control panel of Figure 1 is not visible or iconized on the center screen of the DAQS console, it needs to be restarted. At this point, it is best to close all terminal windows on the center screen and then start one new terminal window. In this new window:

1. Enter “setup epics/release/r3.12”, which sets up paths and environment variables.
2. Go to the DAQS display directory: “cd /spa1/code/v2.3/sun/opi”
3. Start the main control display: enter “startMedm”

The display of Figure 1 should now appear on the screen and all data fields filled.

4.2.2. Main Control Panel is Operational

When the VME processors which collect and frame data are first powered on or reset, the main control panel display will show:

- DCU Status (field 4): IDLE
- FB Status (field 5): NO Config
- Last File (field 9): SYSTEM NOT CONFIGURED!!

To bring the DAQS online from this point:

1. If, and only if, it is desired to remove all data presently on the DAQS disk drive, click on the FLUSH button (item 12 of Figure 1: Main Control Panel). ***Note that this is a non-reversable process. Once started, the data contained on the disk drives will ALL be deleted.*** This is usually desireable only if the DAQS has not been running for some time and the data is no longer of interest.
2. Click on the “Config” button (item 2). This configures the DAQS for operation. A message will appear in field 9 that the system is being configured. This will take ~20-30 seconds, after which the “FB Status” will indicate “IDLE”.
3. The DAQS is now ready to acquire data. To actually start the acquisition process, click on the “Start” button. The “DCU Status” and “FB Status” fields should go from “IDLE” to “Acquiring”. The Frame Count and Accum. Time should start incrementing and the “Last File” field should start showing the names of frame files as they are stored.

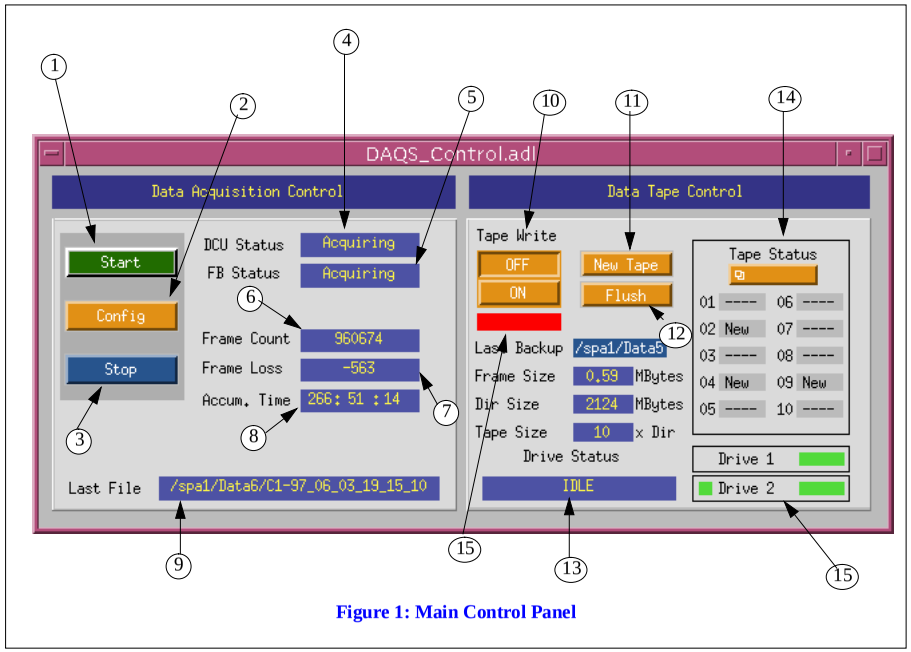

Figure 1: Main Control Panel

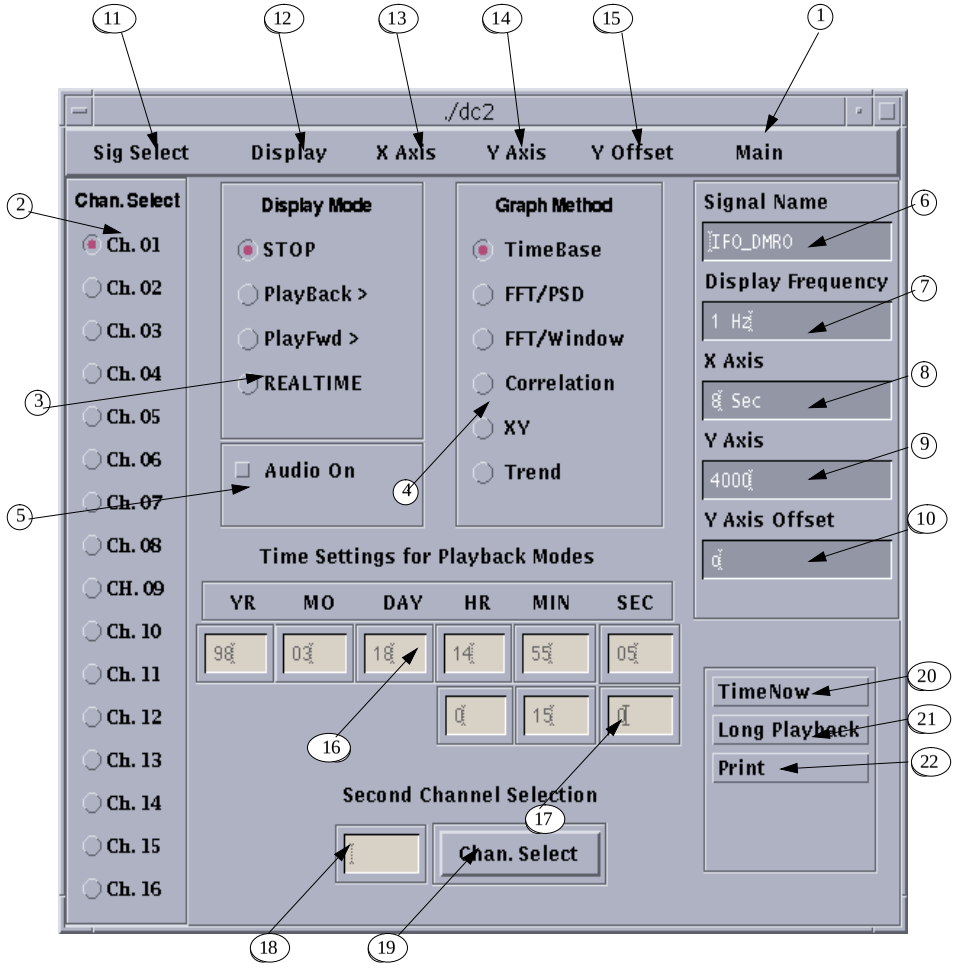

Figure 2: Data Display Control Panel

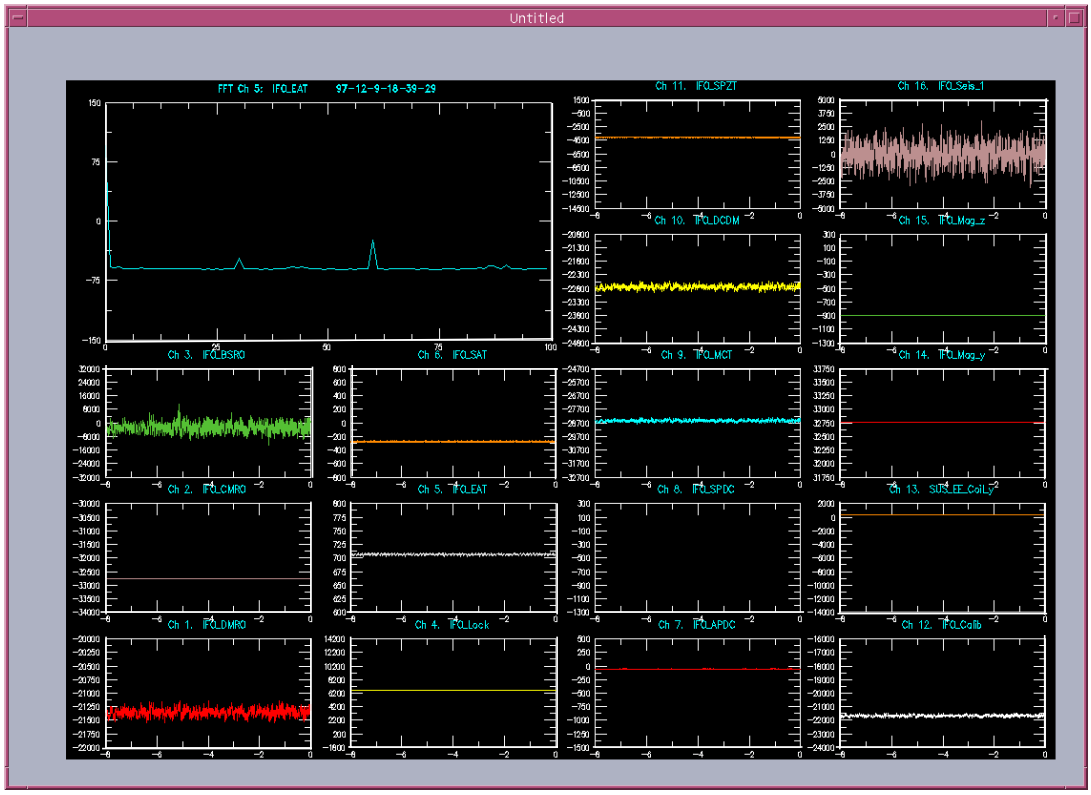

Figure 3: Xmgr Display

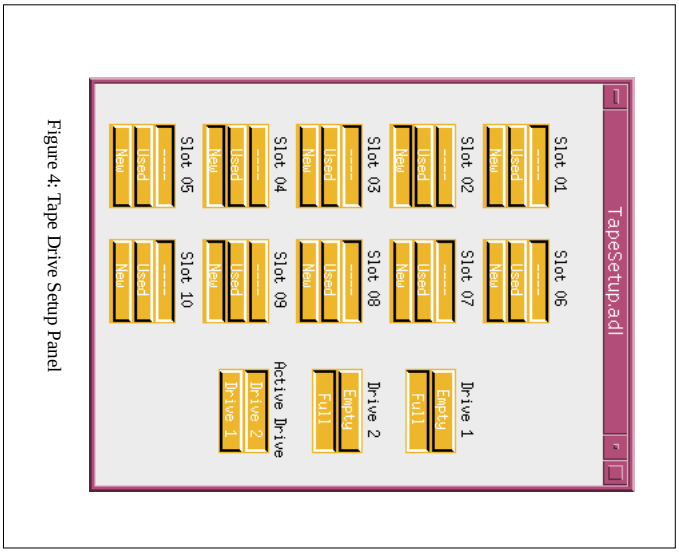

Figure 4: Tape Drive Setup Panel

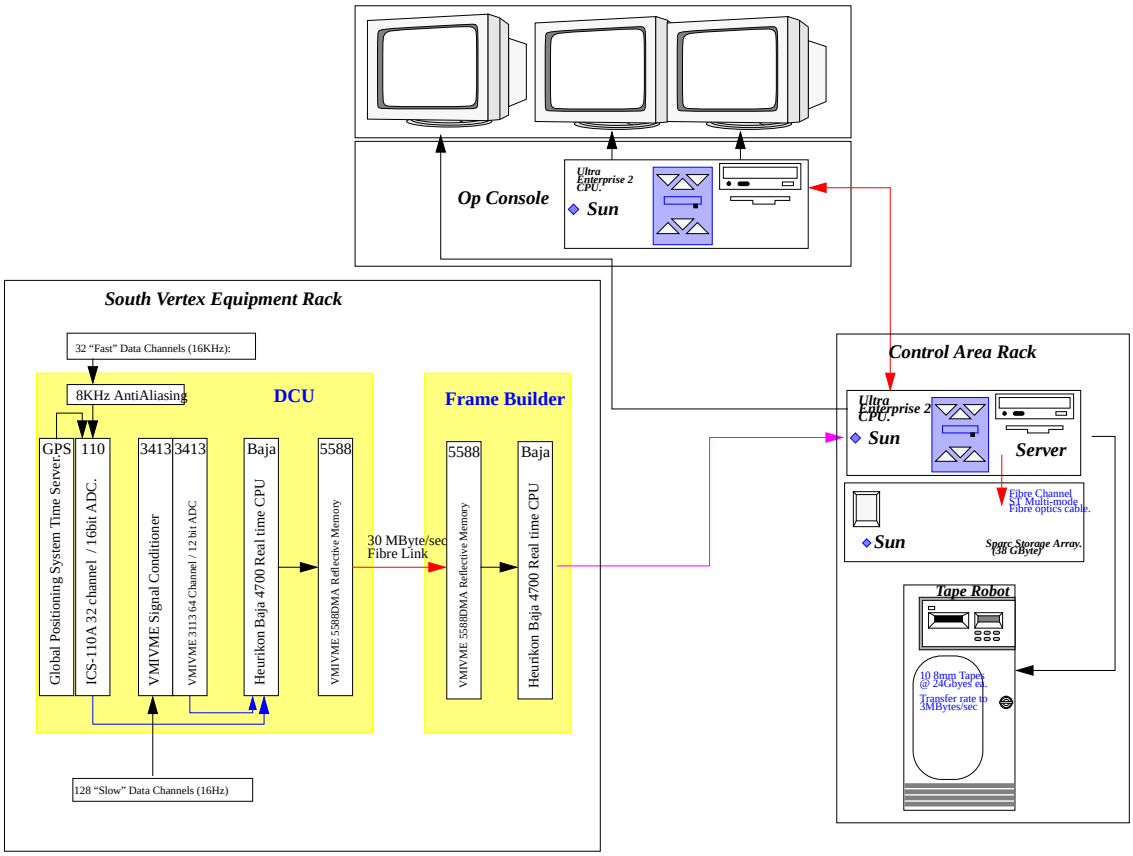

Figure 5: System Overview