Tristan Technologies

babySQUID®

Neonatal Biomagnetometer

System Controller User Interface

TRISTAN TECHNOLOGIES, Inc
San Diego, California
USA

CAUTION — Investigational Device.
Limited to investigational use only.

Tristan Technologies, Inc. Part No. MKT- MAN-2064-002

Revision Record		
Date	**Revision**	**Description**
24 Nov 2003	Version 1.0	First version

Any questions or comments in regard to this product and other products from Tristan Technologies., please contact or see www.tristantech.com:

Tristan Technologies
6185 Cornerstone Court East, Suite 106
San Diego, CA 92121 U. S. A.
Technical Support: (858) 550-2700
Fax: (858) 550-2799
E-mail: info@tristantech.com

WARRANTY

TRISTAN TECHNOLOGIES Limited Warranty

TRISTAN TECHNOLOGIES Inc. warrants this product for a period of twelve (12) months from date of original shipment to the customer. Any part found to be defective in material or workmanship during the warranty period will be repaired or replaced without charge to the owner. Prior to returning the instrument for repair, authorization must be obtained from TRISTAN TECHNOLOGIES Inc. or an authorized TRISTAN TECHNOLOGIES service agent. All repairs will be warranted for only the unexpired portion of the original warranty, plus the time between receipt of the instrument at TRISTAN TECHNOLOGIES and its return to the owner.

This warranty is limited to TRISTAN TECHNOLOGIES' products that are purchased directly from TRISTAN TECHNOLOGIES, its OEM suppliers, or its authorized sales representatives. It does not apply to damage caused by accident, misuse, fire, flood or acts of God, or from failure to properly install, operate, or maintain the product in accordance with the printed instructions provided.

This Warranty Is In Lieu Of Any Other Warranties, Expressed Or Implied, Including Merchantability Or Fitness For Purpose, Which Are Expressly Excluded. The Owner Agrees That TRISTAN TECHNOLOGIES' Liability With Respect To This Product Shall Be As Set Forth In This Warranty, And Incidental Or Consequential Damages Are Expressly Excluded.

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1.0.0 – Introduction

The control software for the babySQUID® system being supplied to the University of New Mexico is installed on a PC workstation, a Dell Model Precision 450. This PC is referred to as “SysCon” (standing for System Controller computer) in this manual. Via a fiber optic link, this software controls the data acquisition unit, and retrieves a live data stream that is processed and used for real-time visual displays, which are useful for rapid project development and system diagnostics. The same software can also be used in a “playback” mode to do off-line analysis of saved raw data, for more detailed studies. The SysCon software is written using the LabVIEW™ development environment. Double-clicking on the LabVIEW icon on the SysCon console will start the acquisition software package.

General features of the LabVIEW software package:

Descriptive information about various items can be obtained by putting the mouse cursor on the item and then pressing <control>-h. This will bring up a panel with a brief description of the item selected. Moving the mouse around will show help for any other item. Pressing <control>-h again will close the help panel.

When multiple panels are displayed, only the top panel is active. The top panel must be closed (typically by pressing the <Exit> button) to make the lower panel active.

It is possible to view various configuration files (*.cfg files), used in the setup and acquisition of data, in either Excel or Notepad. If *.cfg files are edited in Excel, they will no longer function properly; if edited in Notepad, they likely will work fine. However, it is recommended to do any editing using the LabVIEW tools provided for that purpose.

In general, fields that are colored white can be user-edited, and fields that are gray cannot.

In general, controls that are colored yellow are used frequently.

2.0.0 – System startup and preliminary checkout

After double-clicking on the acquisition software icon on the SysCon console, the Booting System panel will appear, as shown in **Figure 1**.

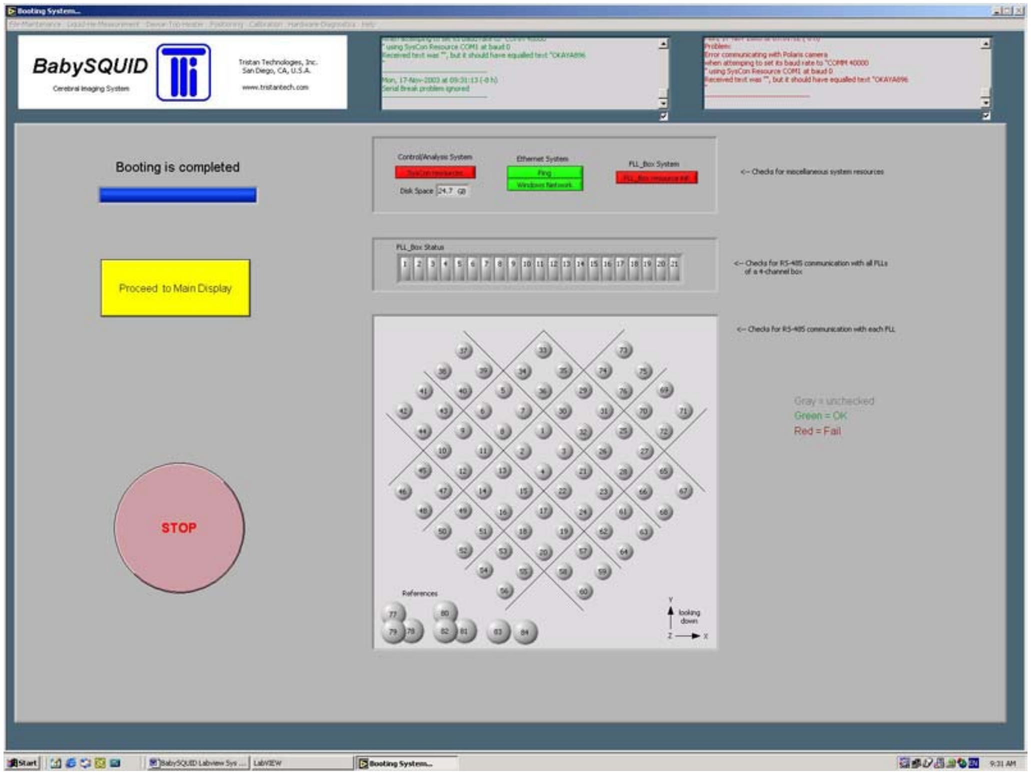

Figure 1: Booting System

The items on the right represent the different system components. The color of these components will switch from gray to either red or green as each component is verified to be in an operational state. If any item becomes red, this is an indication that the particular item is not in an operational state.

The upper rectangular block shows the status of the various parts of the data storage and computer analysis systems. The available disk space is indicated for SysCon.

The block labeled Microcontroller Status represents the 21 FLL controller units. Each unit handles four SQUID channels, as indicated in the *View FLL Mapping* panel in the Hardware-Diagnostics menu, that lists the details of which SQUID channels are connected to which FLL controller units.

The next big block shows 84 “buttons” representing the 84 SQUID channels. Green buttons represent working RS-485 communication with the channels; they do not represent SQUIDs being properly tuned (good triangles) and with their outputs on scale. The eight buttons at the bottom (#77 through #84) are for the eight reference channels used for environmental noise reduction. The signal channel layout schematically represents the signal channel layout in the head bowl, looking down. This display is a flattened approximation; the coils are actually laid out as an ellipsoidal surface.

3.0.0 – System Controller

When booting is completed, the user presses the large yellow button to proceed to the main System Controller panel, as shown in **Figure 2**.

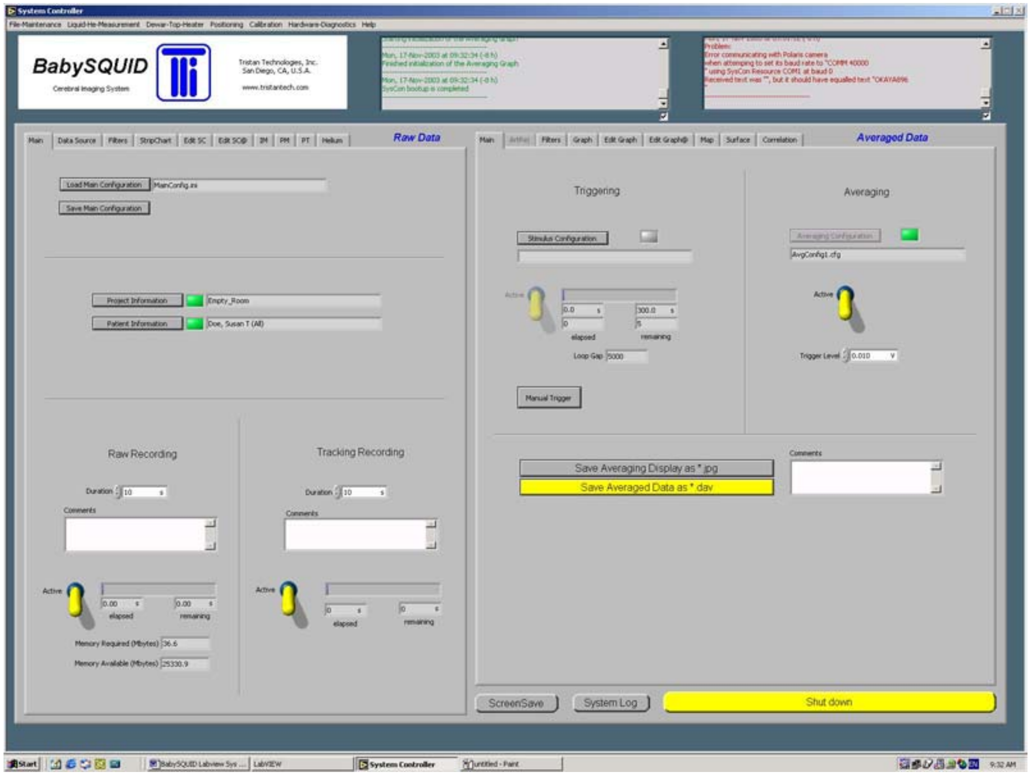

Figure 2: System Controller

At this point during system start-up, there will be an automated sequence of configuration screens that pop-up and then disappear. When this is completed, the user is then free to operate the system.

The menu bar at the top of the panel shows 7 items that lead to useful tools and information: *File-Maintenance, Liquid-He-Measurement, Dewar-Top-Heater, Positioning, Calibration, Hardware-Diagnostics,* and *Help*. These items are discussed in the System Controller Menu Bar section.

A pair of System Messages windows is located in the upper right portion of the System Controller panel; the left box (green text) contains all messages, and the right box (red text) contains only error messages. During system startup, the system is checked and descriptive messages are posted. Later, during system operation, user activity and any problems encountered are posted. This information is continually stored as a log file, and forms a useful record of experiments. All entries are time-stamped. The small checkbox, next to each message box, forces the list to be at the bottom (most recent). The user can add their own notes to the System Messages (and thus add to the log files) by pressing the System Log button near the bottom of the screen.

On the left side of the System Controller panel is a set of tabs for configuring, displaying, and saving the raw data stream. On the right side is a set of tabs for using this raw data stream to perform trigger-based averaging. Both of these tabset sections are described in detail below.

4.0.0 – RawData tabset

This set of tabs is for configuring, displaying, and saving the raw data stream.

4.1.0 – RawData tabset >> Main

This particular tab allows the user to do primary functions, such as loading/saving main configurations, and saving raw and tracking data.

4.1.1 – RawData tabset >> Main >> Load Main Configuration

If an acquisition is to be done using all the same information from a previous acquisition, then the *Load Main Configuration* button can be used to bring up the Main Configuration panel, as shown in **Figure 3**.

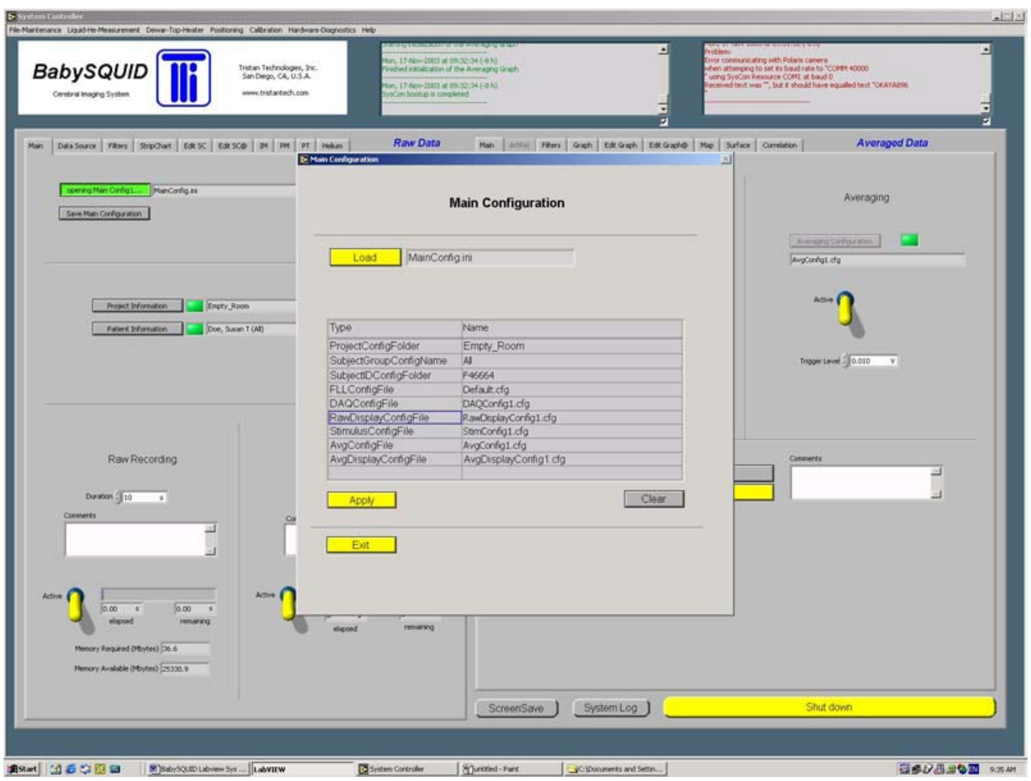

Figure 3: Main Configuration

This panel allows one to recall the set of configuration files from a previous experiment. Pressing the *Load Old Main Configuration* button will bring up a list of the stored configurations; once one is selected, its name will appear in the text window and the names of the configuration files will appear in the listing below. Pressing the *Apply* button will load the information, then *Exit* will return the user to the System Controller panel.

4.1.2 – RawData tabset >> Main >> Save Main Configuration

For commonly used sets of configuration files, the user can save the set by using the *Save Main Configuration* button. In this window, a name may be chosen, with an ".ini" extension, and the set is recorded for future usage.

For the user's convenience, the software automatically edits a special *.ini* file called "*MainConfig.ini*" whenever any configuration window is visited. Thus, the user will always have access to a record of the most recent experiment to refer to, in addition to the ones the user has created. The user should <u>not</u> overwrite this particular file manually from the Save Main Configuration panel.

4.1.3 – RawData tabset >> Main >> Project Information

The *Project Information* panel is used when specifying the project of the study, as shown in **Figure 4**.

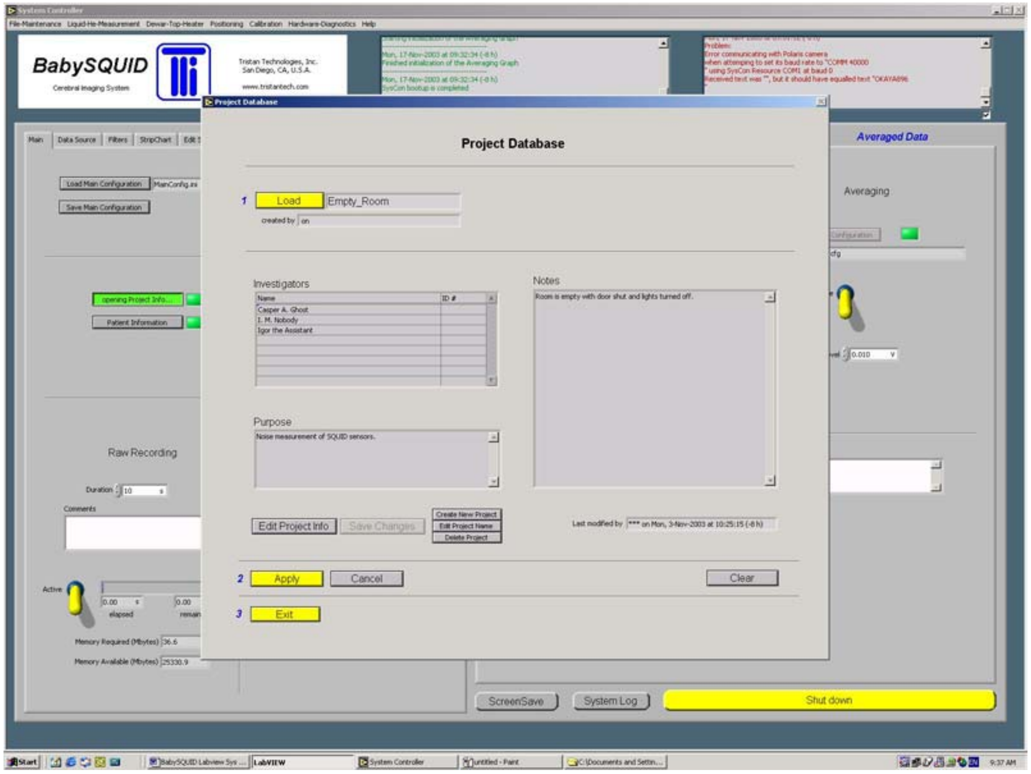

Figure 4: Project Information

The *Load Project* button can be used to bring up a list of past projects, which can be selected and loaded. Note that the folder must be selected, not just highlighted. If project information is to be changed, or a new project is to be created, then the *Edit Project Info* button should be pressed; then the list of Investigators, the project Purpose, and any Notes may be entered. When finished editing, press the *Save Project Info* button; this will bring up a window allowing the user to overwrite or rename the project. Finally, pressing the *Exit* button will load the project information onto the System Controller panel while closing the Project Information panel and turning the Project Information indicator green.

Note the *Delete Project* button. It is recommended to be very cautious about deleting a project. Once deleted, the project will no longer appear in the database. However, that project name, and project information, will still exist in the header information for any archived data acquired under that project name. It is desirable to avoid this situation, since having data with headers indicating projects that no longer exist could lead to confusion.

Note that the project database is structured as folders rather than files. This allows for great flexibility in storing diverse information, such as image and audio files.

Finally, pressing the *Exit* button will load the project information onto the System Controller panel while closing the Project Information panel.

4.1.4 – RawData tabset >> Main >> Patient Information

The *Patient Information* panel is used when specifying the patient undergoing the study, as shown in **Figure 5**.

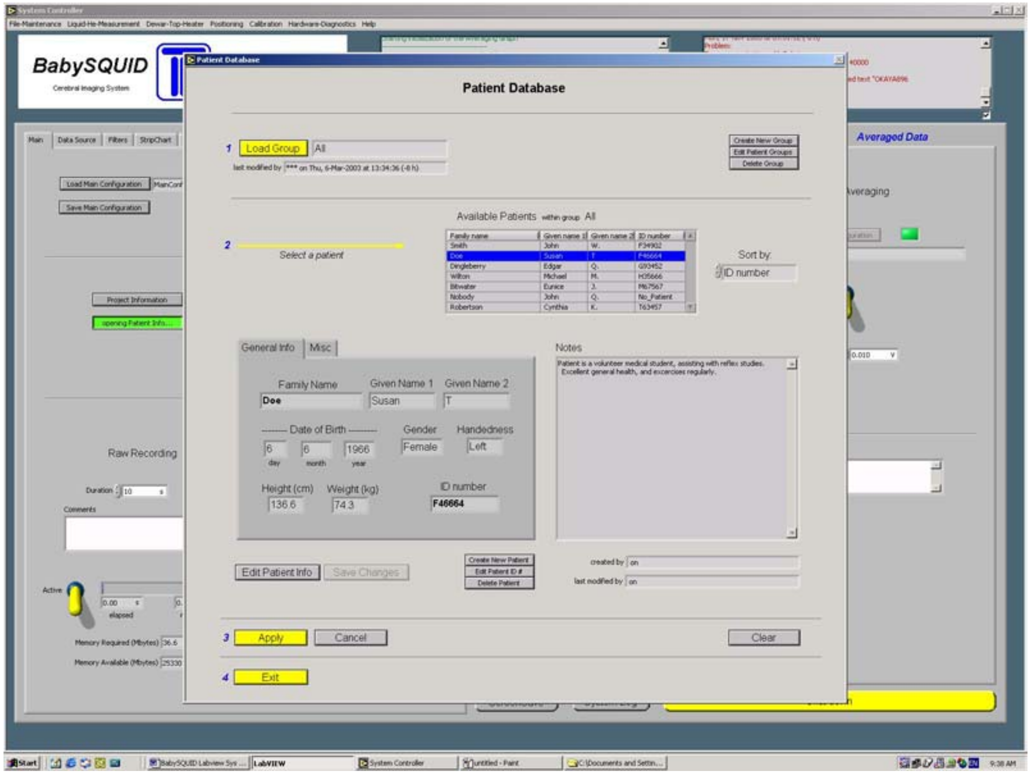

Figure 5: Patient Information

All patients are members of the group *All.txt*; in addition, patients may be members of zero or more other groups. To select an existing patient, a group containing the patient must be loaded into the panel using the Load Group button; then the patient may be selected from the Available Patients list. Data for a new patient may be entered using the *Create New Patient* button in the lower, central portion of the panel. The indicated information blanks should be filled in with text (automatically stored in the StandardFields.txt file). The *Misc* tab brings up three more entry places for patient parameters that might need to be tracked — e.g., eye color (automatically stored in the UserFields.txt file). If old patient data have been updated or new patient data entered, then pressing the *Save Patient Info* button will save the patient data.

In the upper right hand corner of this panel is a button called *Edit Patient Groups*. Pressing this button brings up a window allowing patients to be added or removed from the various groups; patients cannot be removed from the *All.txt* group. The *Create New Group* button brings up a panel to create a new group name; then the Edit Patient Groups panel can be used to select patients to be members of the new group. There is also a Delete Group panel allowing group names (not patients) to be deleted; since the headers of archived data will not be modified, it is recommended to proceed cautiously when thinking about deleting a group.

The *Delete Patient* button allows a patient to be deleted. It is recommended to be very cautious about deleting a patient. Once deleted, the patient will no longer appear in the database. However, the patient name, and patient information, will still exist in the header information for any archived data acquired with this patient. Having data for patients who no longer exist could lead to confusion.

The *Edit Patient ID #* button allows a patient ID number to be changed. It is strongly recommended not to change this number. The patient ID number is used as a database key, and is thus a reference throughout the software. If it is changed, the patient ID number will be updated throughout the patient database. But, the number stored with all archived data will not be updated; thus all stored data associated with the old patient ID number will no longer have a correct match in the patient database.

Note that the patient database is structured as folders rather than files. This allows for great flexibility in storing diverse information, such as image and audio files.

Finally, pressing the *Exit* button will load the patient information onto the System Controller panel while closing the Patient Information panel.

4.1.5 – RawData tabset >> Main >> Raw Recording

This section controls the saving of raw data to a mixed ASCII/binary file called RawData.bin. This file is located under a ~/ExperimentData/Project/Subject/Date/*_Raw directory tree, where the ~ root directory is specified by the user in MainConfig.ini (or other user-selected *.ini file). The raw data can come either from a real-time experiment, or from a data playback or simulation (see below). The user sets the recording time, and writes in any commentary, which is written near the beginning of the raw data file.

Toggling the yellow “Active” switch to ON will initiate recording. The recording can be prematurely terminated by switching to off.

The RawData.bin file contains some ASCII information near the beginning to specify certain critical pieces of information. However, it is inconvenient to put a complete system description there. Thus, in addition to generation of the RawData.bin file, the system automatically generates a Header folder along with it, which contains a variety of current system configuration information.

4.1.6 – RawData tabset >> Main >> Tracking Recording

This section controls the saving of tracking data to a mixed ASCII/binary file called Tracking.bin. This file is located under a ~/ExperimentData/Project/Subject/Date/*_Tracking directory tree, where the ~ root directory is specified by the user in MainConfig.ini (or other user-selected *.ini file). The tracking data comes from the Polaris camera while it monitors the locations of the HeadTool and BedTool. The user sets the recording time, and writes in any commentary, which is written near the beginning of the tracking data file.

Toggling the yellow “Active” switch to ON will initiate recording. The recording can be prematurely terminated by switching to off.

The Tracking.bin file contains some ASCII information near the beginning to specify certain critical pieces of information. However, it is inconvenient to put a complete system description there. Thus, in addition to generation of the Tracking.bin file, the system automatically generates a Header folder along with it, which contains a variety of current system configuration information.

4.2.0 – RawData tabset >> Data Source

This controls the type of incoming data.

4.2.1 – RawData tabset >> Data Source >> Channels

This section controls the type of incoming data by using a rotary knob, as shown in **Figure 6**.

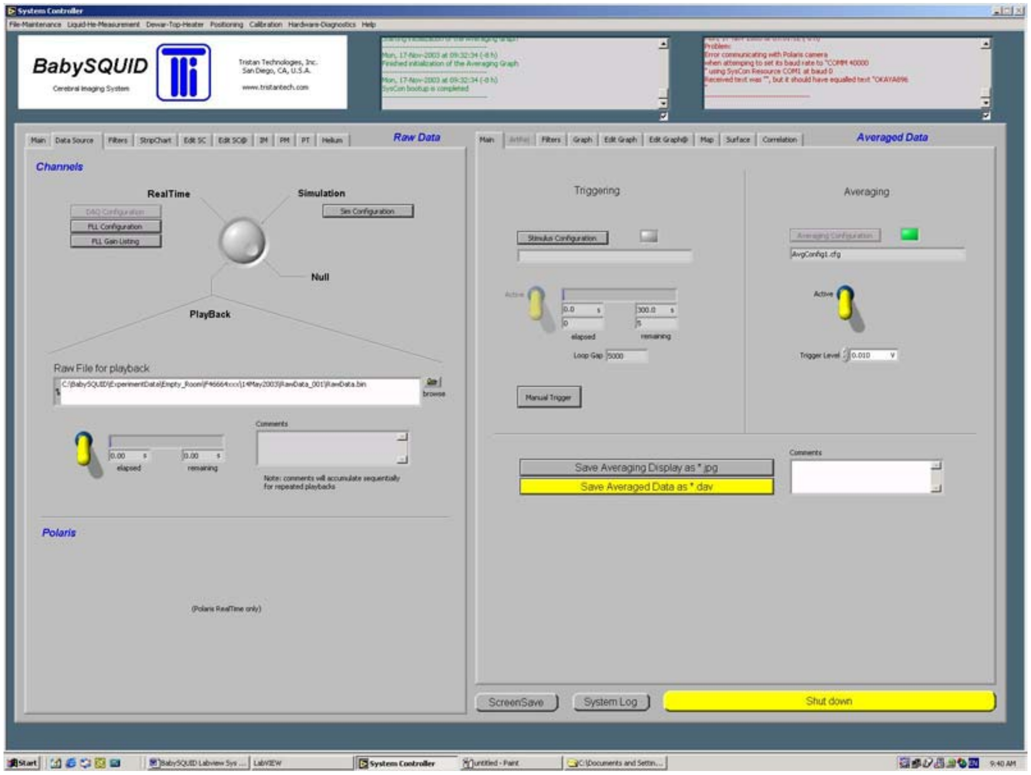

Figure 6: DataSource Channels

When set to RealTime, live data will be read from the data acquisition unit (which in turn is connected to the FLLs and then to the SQUID sensors). Alternatively, data can come from a Simulation or from Playback, where it is treated just as if it were live data.

In the Null position, no data is streaming through the system.

4.2.2 – RawData tabset >> Data Source >> Channels >> RealTime >> DAQ Config

The DAQ Configuration panel allows the user to set the data acquisition rate and block size.

4.2.3 – RawData tabset >> Data Source >> Channels >> RealTime >> FLL Config

The FLL Configuration panel allows the user to control and monitor operation of the FLL units, as shown in **Figure 7**.

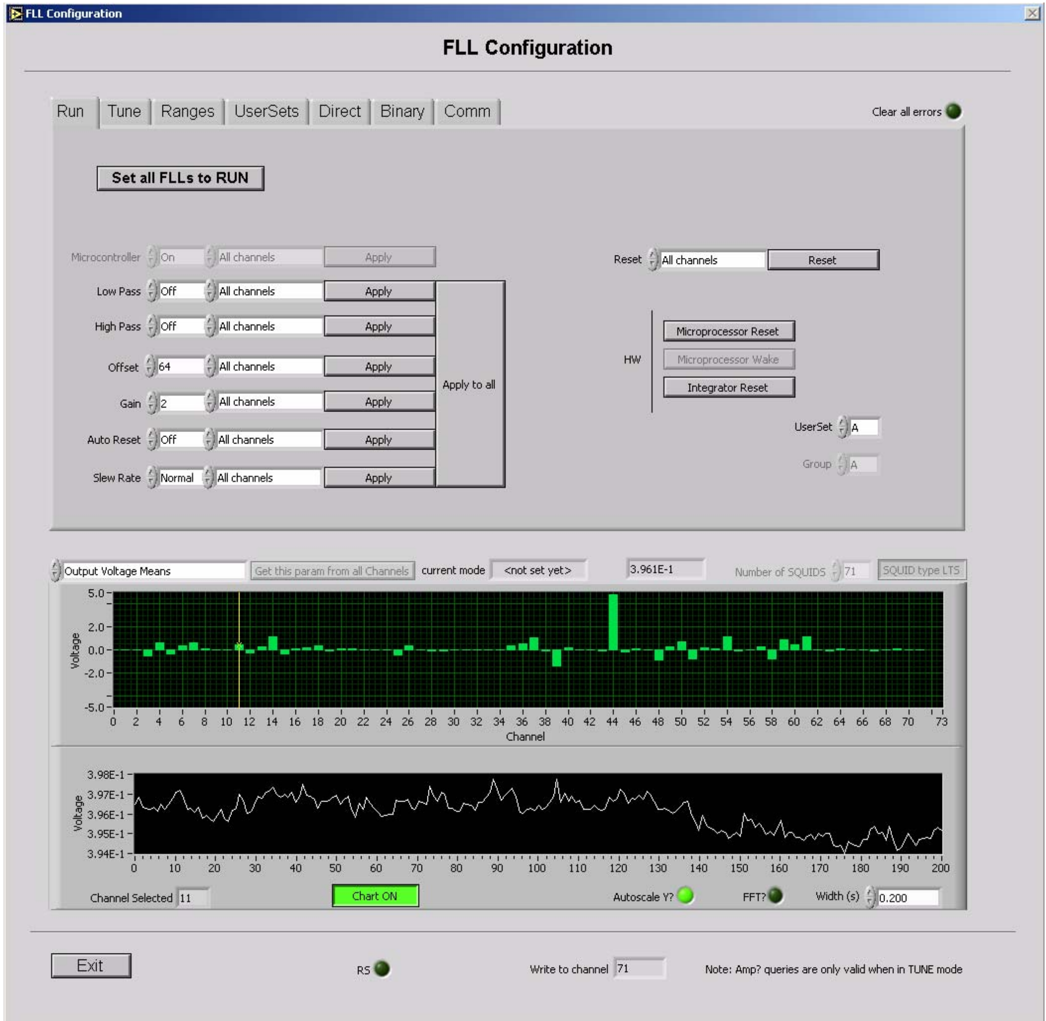

Figure 7: FLL Configuration (Run)

Under the **Run** tab, seven SQUID controls can be set. The leftmost pull-down listbox contains the possible settings for the item. (Note that Offset item values may be manually entered.) The second pull-down listbox indicates the channel group to which the setting indicated in the first pull-down listbox is applied. Pressing the *Apply* button loads the indicated setting into the indicated group of channels; at the far right of this tab sheet is a “Set all” button which sets all seven items in one step.

The Microcontroller item can be set to On, Off, or Sleep. The On selection is necessary for any data to be obtained from the indicated channel group, and for the other items on this tab sheet to be applied. Off would be selected if channel(s) are not functioning properly and hence are to be removed from the system. The Off selection is equivalent to removing the SQUID electronics for the indicated channel group.

The Low Pass item refers to the hardware low pass filter supplied with each SQUID channel. This item may be either On or Off.

The High Pass item refers to the hardware high pass filter supplied with each SQUID channel. This item may be either On or Off.

The Offset indicates the DC offset output voltage for the selected channel group. When SQUID channels are reset, their output voltage is set near 0.0 volts. This item allows the output voltage reset point to be values other than 0.0 volts.

The Gain for each SQUID channel can be set to x1, x10, or x100. For large signals or large environmental noise, x1 may be the necessary setting. For a quiet environment and maximum sensitivity to small signals, the user would select x100.

The Auto Reset can be set On or Off. This item refers to whether or not the SQUID output is automatically reset to 0.0 volts when it exceeds the dynamic range of the electronics. If the output exceeds ± 5 volts, the Off selection means that the output would just remain "railed" at this output extreme value; the On selection means that the output would be reset to 0.0 volts, from which point it would continue to respond to magnetic field changes. In either case, allowances will have to be made in data analysis when SQUID outputs are railed or reset.

The Slew Rate may be set to Normal or Slow for the indicated group of output channels. For SQUID systems, the slew rate refers to the ability to follow rapidly changing magnetic signals. The Normal slew rate will follow more rapidly changing signals than the Slow slew rate. Stated differently, the Slow slew rate has a lower bandwidth than the Normal slew rate. As a consequence, channels with a Normal slew rate will be more susceptible to problems from high frequency interference. If the Slow slew rate provides an acceptable bandwidth for the signals of interest, it is the slew rate to use; the output will be more stable, less susceptible to unlocking and output jumps, in the Slow mode.

To the right is a *Manual Reset* option. When the Reset button is pressed, the outputs for the selected channel group will be reset to 0.0 volts. At the lower left of the panel is an *Exit* button. When pressed, all SQUIDs will be put into the RUN mode and the panel will be closed. Tuning as set under the Tune tab and Run parameters as set under the Run tab will be used in the SQUID channel settings. If SQUID settings are to be left as they were when the FLL Configuration panel was opened, then the panel should be closed using the *Cancel* button, also in the lower left.

The **Tune** tab (**Figure 8**) display allows examination of individual channel. A menu above the 71 SQUID channel display allows the following to be selected: Mean Tuning Voltages; Mean Output Voltages; Analog Low Pass Status; Analog High Pass Status; Offset Status; Gain Status; Auto Reset Status; Slew Rate Status. The various controls under the Tune tab allow SQUID tuning to be optimized

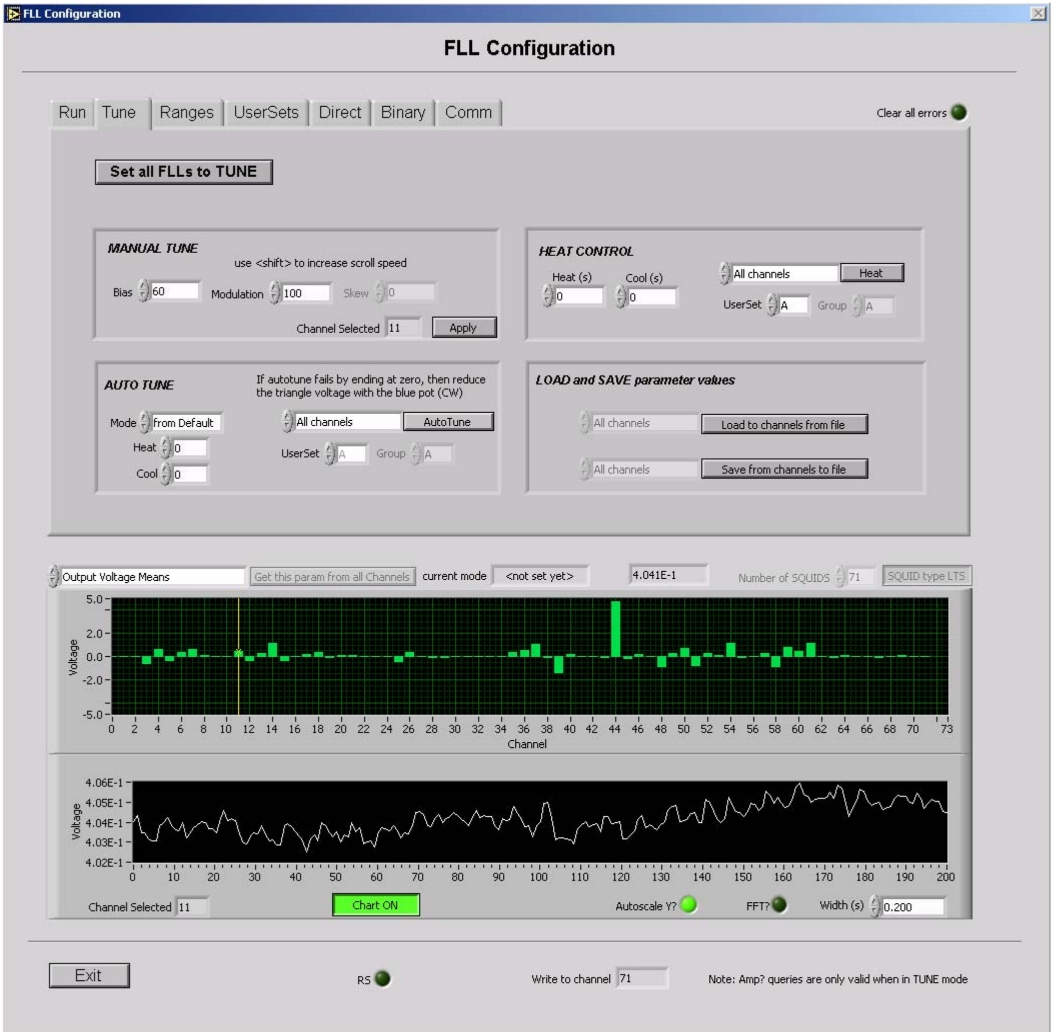

Figure 8: FLL Configuration (Tune)

The status of any particular channel can be viewed in the display window just below the 71-channel display. For voltage selections, this display is a time series display of the voltage. The selected individual channel is indicated by the vertical yellow line in the 71-channel display. This line may be moved to a different channel by placing the cross-shaped cursor with the vertical portion of the cross over the yellow line, then holding down the left mouse button and pulling the yellow line to the desired position.

The HEAT CONTROL is supplied to allow trapped flux to be removed from SQUIDs; if flux is trapped, this will degrade performance. Heating the SQUID causes the SQUID loop to temporarily lose superconductivity, which causes the trapped flux to dissipate. One can select the duration that heat should be supplied to each SQUID; typically this is 10 seconds. The COOL time is simply a wait for the liquid He to cool the SQUID back down to 4.2 K. The channel(s) to be heated can be selected in the Heat Channels menu, and then heating is started by pressing the Heat button. If one desires to heat just one SQUID, the user must create a group (either A, B, or C) having that one channel in it. It is dangerous to heat too many SQUIDs at once, so the user is prevented from doing so.

The AUTO TUNE section allows a selected group of channels to be tuned automatically. The starting point for auto tuning may be selected to be either “from Default” or “from Last”; the latter choice refers to the tuning values last obtained for the each channel. Pressing the Auto Tune button starts the auto tuning process. To tune all channels will typically take 5 minutes.

Auto tuning is typically quite successful, but occasionally one will come up with a problem channel where tuning can be improved via manual tuning. This can be undertaken in the MANUAL TUNE section. There are two controls: the Bias and the Modulation. The Bias is the more sensitive control. The goal in tuning is to maximize the tuning voltage. The range for the two controls is Bias = 1 – 128 and Modulation = 0 – 128. It is suggested to start by setting the Modulation at 60 and then increasing the Bias value, looking for a maximum. Once a maximum is obtained, try varying the Modulation somewhat from its value. Going back and forth between the two controls several times should bring a clear maximum. Note the button in the lower right of this section; there are two scrolling modes for varying the two controls. The “slow scrolling” mode changes values in 0.01 size steps; the “fast scrolling” mode varies values in 0.10 size steps.

The LOAD and SAVE Preset Values section allows the tuning parameters for different groups of channels to be either loaded in from a file or saved out to a file. Once good tuning is obtained for all channels, it is suggested to save all the tuning parameters (Bias and Modulation values for all 71 SQUIDs) for future reference usage. If problems develop with some channels, it is often informative if one can say that the Bias, or Modulation, value appears to be less (or more) than it was previously when all was fine. For loading in, a default set of tuning parameters is hard coded into the system based on values when the system was operating well for Tristan technicians.

The **Ranges** tab (**Figure 9**) allows the user to choose the displayed ranges for the selected channel. The user sets the voltage limits for the tune and run modes; these will be set at the time of installation and should not require further adjustments. Under Tune Voltage, the user sets the No Pass Limit; this is the voltage below which the SQUID is considered untuned. Typically, this will be set at 3.0 Volts. The Graph Maximum and Graph Minimum values are used for the two graphical displays in this panel when tuning voltages are selected. Because the tuning voltage is an amplitude, typically the Graph Minimum will be 0.00 volts and the Graph Maximum will be 5.00 volts.

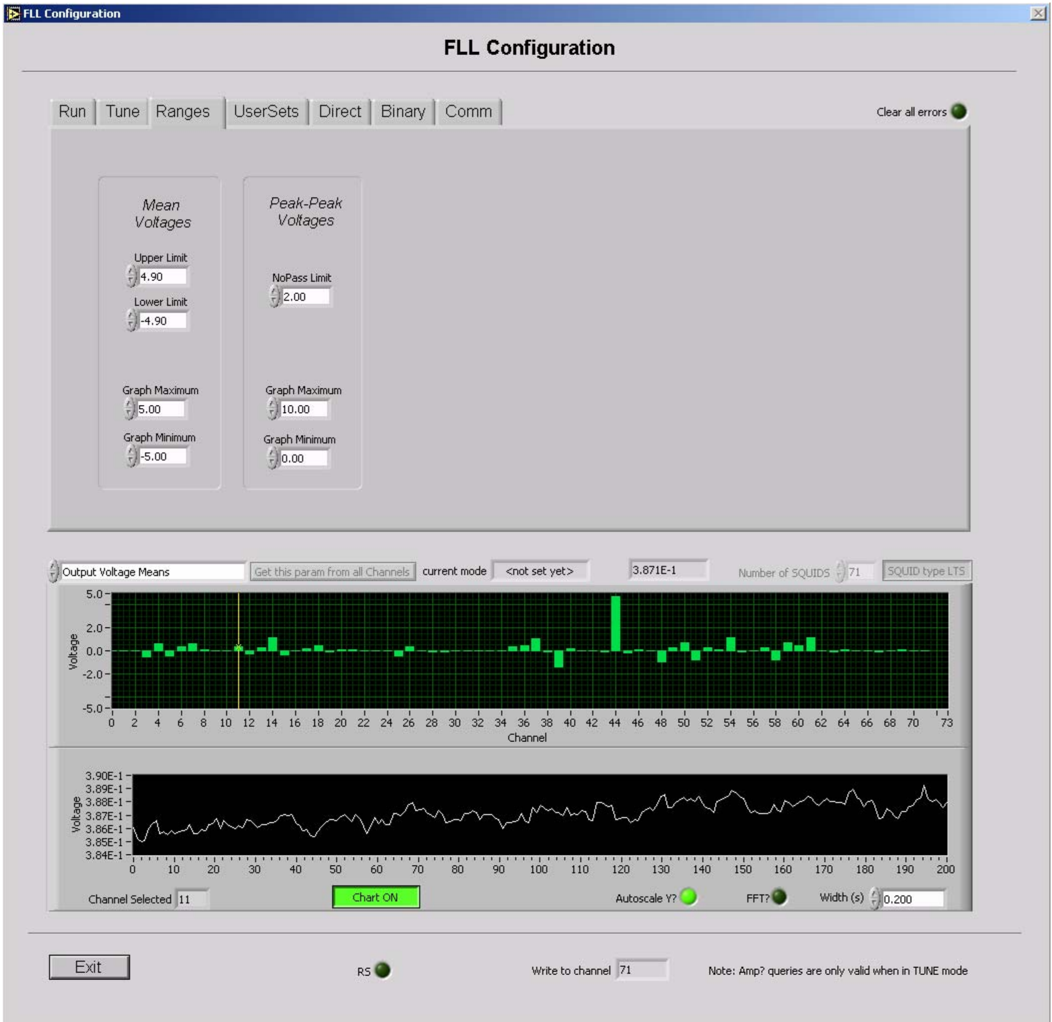

Figure 9: FLL Configuration (Ranges)

The **Channel Sets** tab (**Figure 10**) has controls for setting up groups of channels for use anywhere else within the SysCon software. The Set Source is one of the following choices: <user-defined>, Out of Range (run); Out of Range (tune); Set A; Set B; Set C. Once a set is selected, the channels in the set will be displayed in the listing to the right; the control to the left of the list allows the list to be stepped through if more than 5 channels are in the list. An *Overwrite Set* button appears if the <user-defined> choice is selected; this allows the user defined selection to be saved as Set A, B, or C.

The Channel Sets utilities are modest; these may be expanded in future software versions.

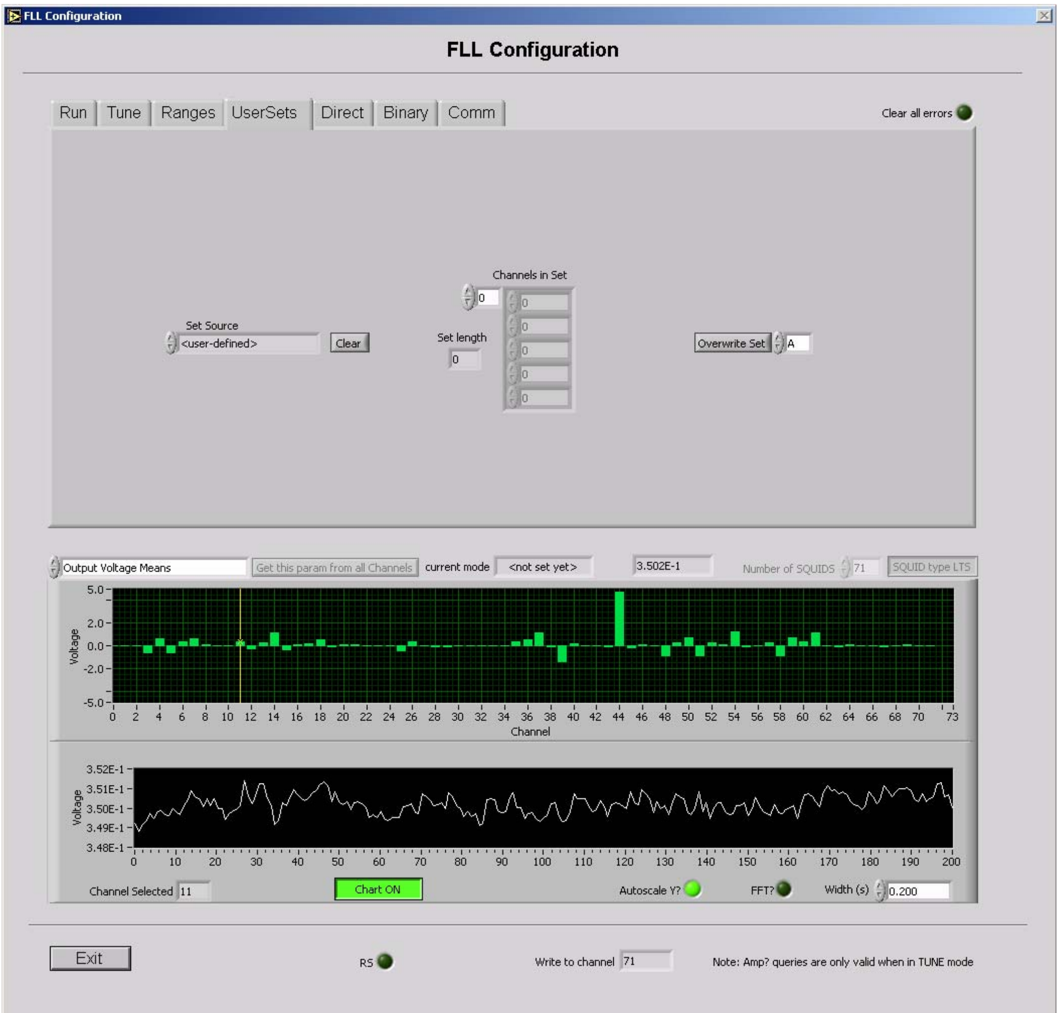

Figure 10: FLL Configuration (Channel Sets)

The **Direct** tab (**Figure 11**) and the **Binary** tab (**Figure 12**) are provided specifically to allow low level SQUID control. The window allows direct entry of commands and viewing of results by individual channel. This capability is provided for diagnostic work by Tristan technicians, and is password protected.

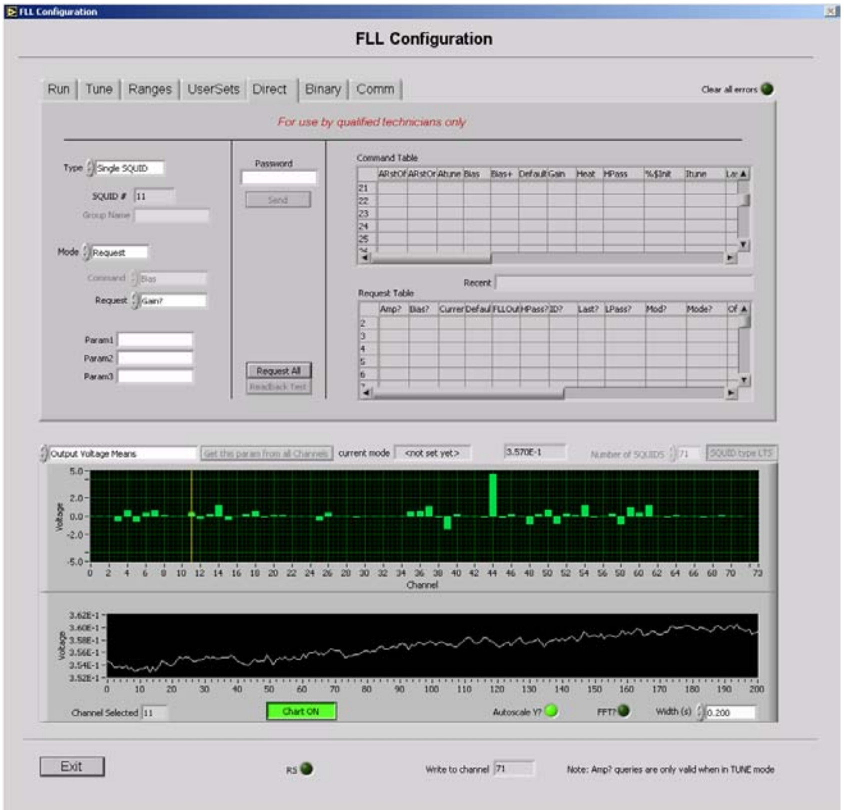

Figure 11: FLL Configuration (Direct)

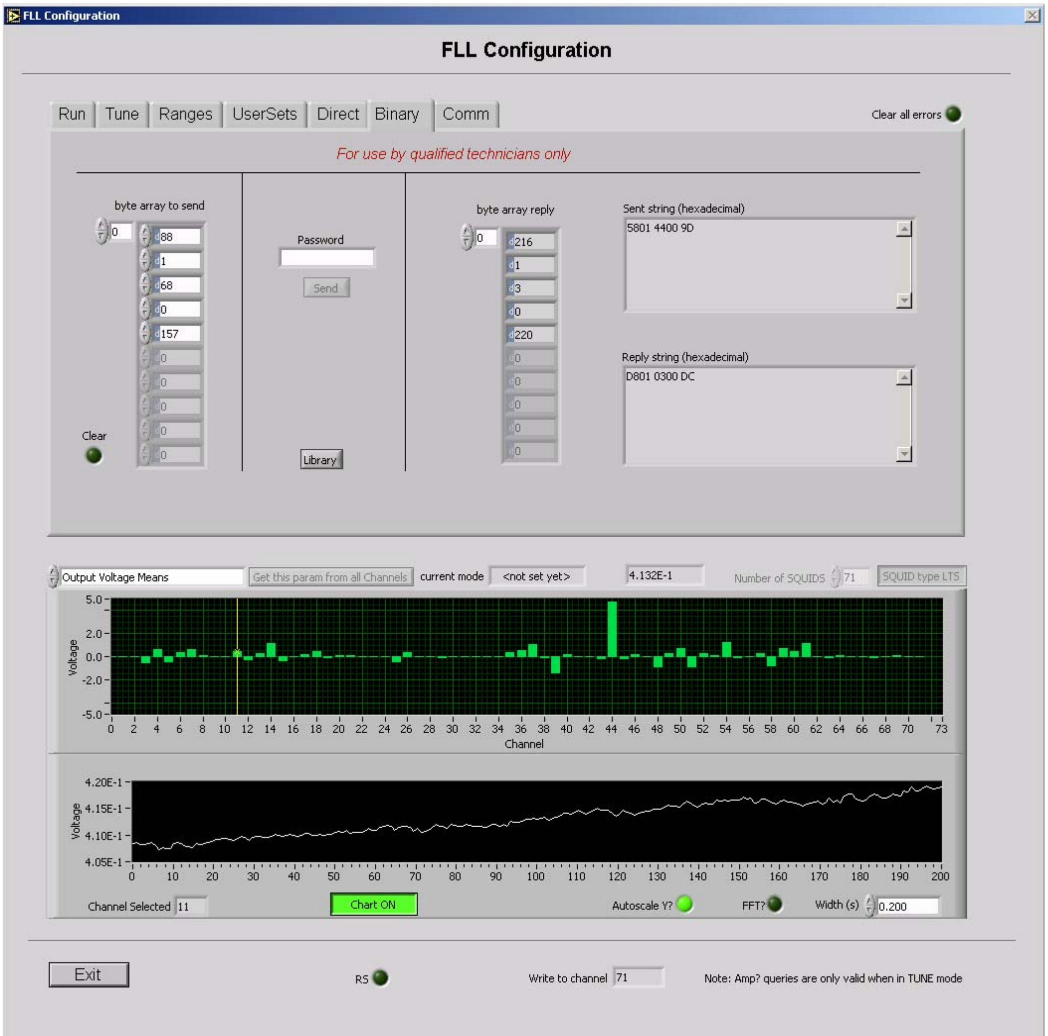

Figure 12: FLL Configuration (Binary)

The **Comm** tab (**Figure 13**) contains controls to be used by the Tristan technicians when installing or trouble shooting the system, and is password protected.

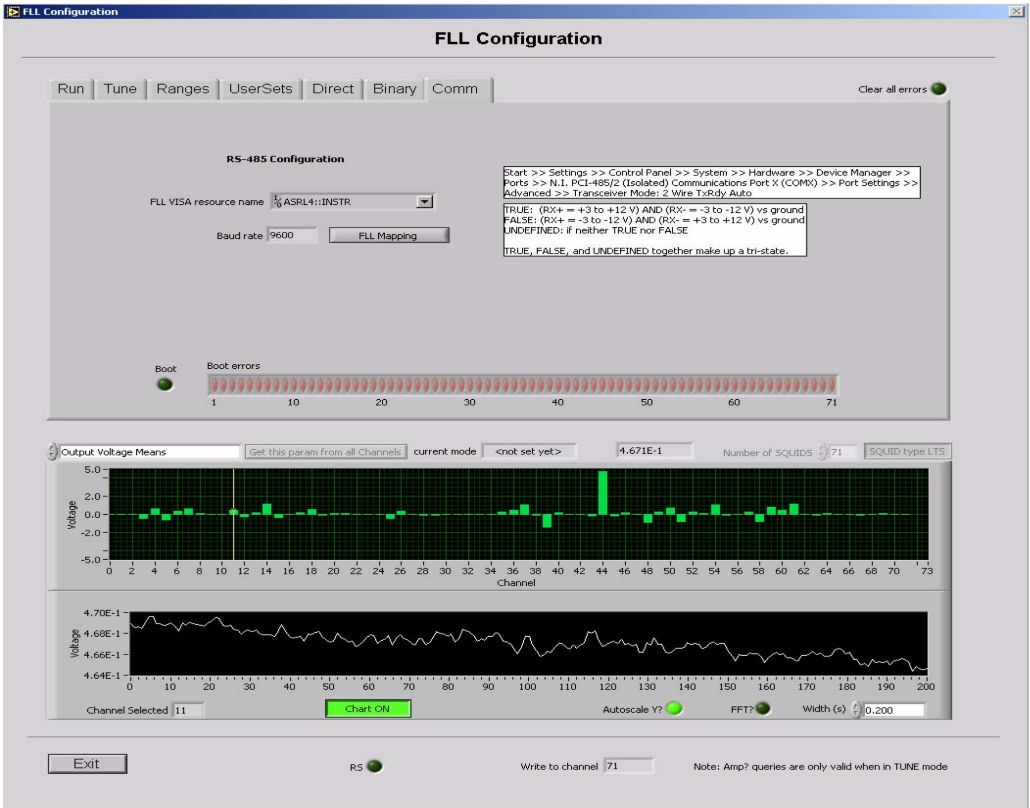

Figure 13: FLL Configuration (Comm)

4.2.4 – RawData tabset >> Data Source >> Chan >> RealTime >> FLL Gain Listing

This allows the user to quickly obtain a listing of the FLL gains, as shown in **Figure 14**. Although the user could also obtain this information from the FLL Configuration panel, this information is needed often enough to warrant a special panel.

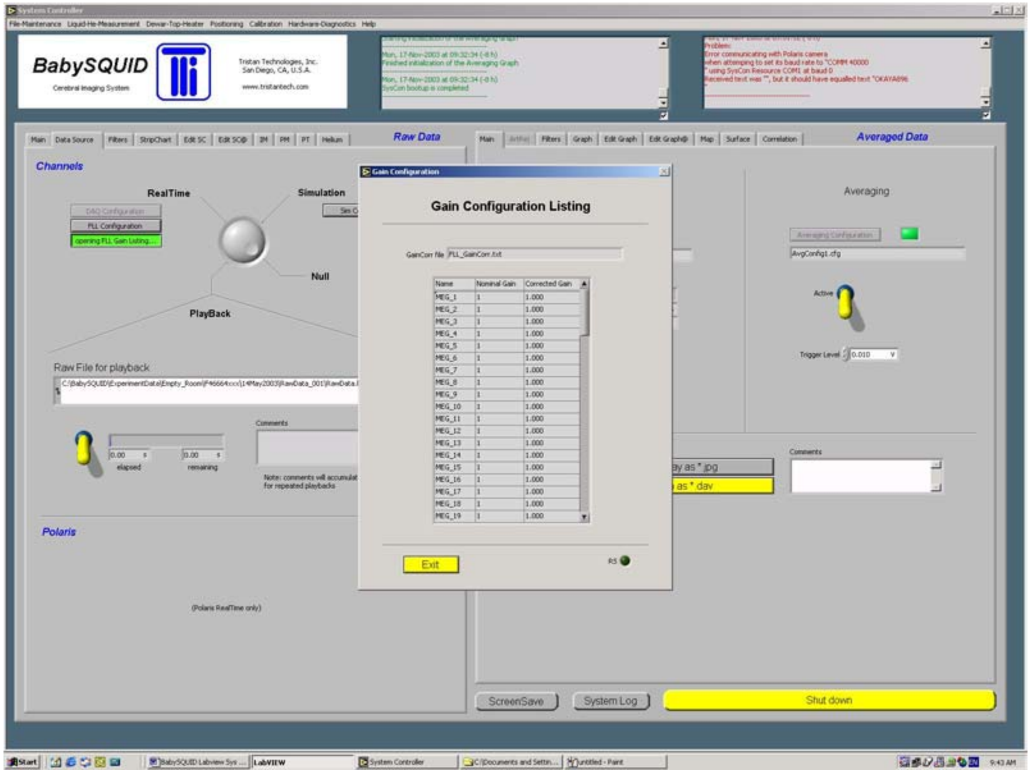

Figure 14: Gain Configuration Listing

4.2.5 – RawData tabset >> Data Source >> Channels >> Simulation >> Sim Config

This utility allows generation of complicated signal + noise combinations. The individual components are discussed below.

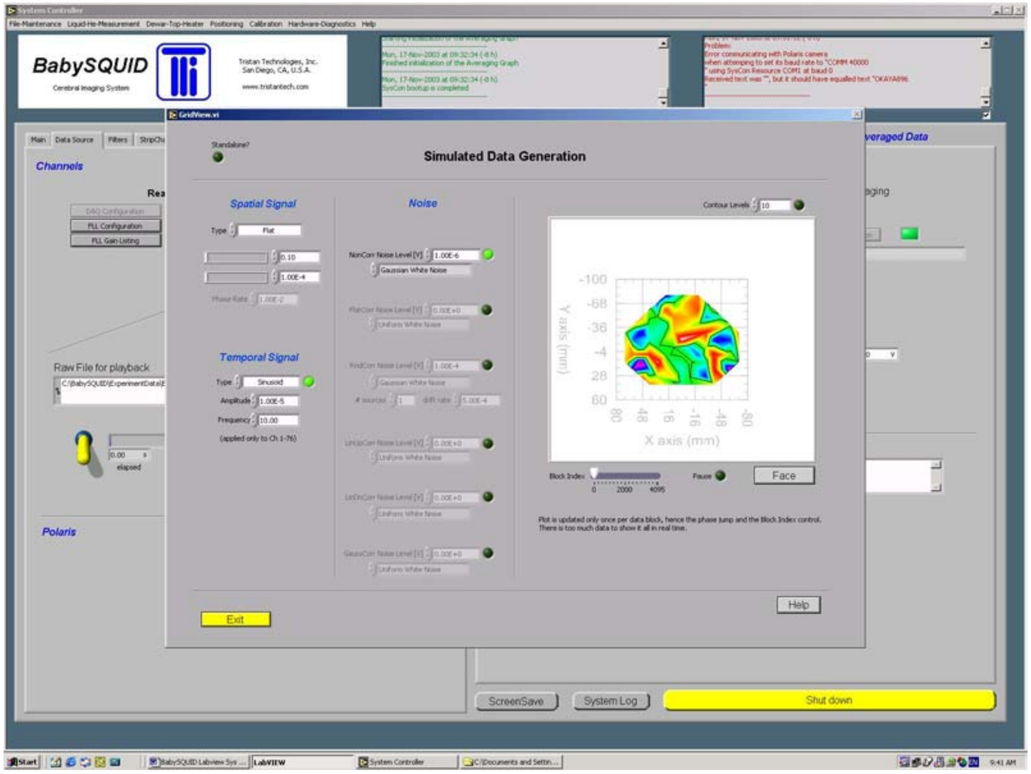

Figure 15: Simulated Data Generation

Temporal signals are simply time-varying functions that are added to all SQUID channels. For example, the user could set a sine wave to be present on all SQUID channels (scaled by their calibration factors, which can be positive or negative). Flat, square, triangle, and sawtooth waves are also available.

Spatial signals vary with the XY coordinates of the SQUID coils. For example, if the user selects Sphere, then the signal near the center of the coil arrangement would have a near-zero DC offset, but the perimeter would have a fairly negative DC component. Selecting Wave1 or Wave2 would show an egg-carton topography.

There is a special provision for making the Wave1 or Wave2 spatial signal phase vary with time, in order to simulate a moving dipole source.

Noise can have correlation structure. If the user selects NonCorrelated noise, then a different random number is separately added to each channel at each point in time, such that there is zero correlation between the channels at any point in time. For FlatCorrelated noise, then a single random number is added to all channels at each point in time, such that there is full correlation.

The situation becomes more complex for intermediate correlation, which better represents real signals. A single random number is first multiplied by a set of weightings (one per channel), then these results are added to the channels at each point in time. The pattern of the weightings defines the correlation. If all the weightings are equal to 1, then the result reduces to simple FlatCorrelated noise. If the pattern of weightings is random, slopes upward or downward, or is Gaussian, then the correlation becomes more complex.

There is a special provision for making the RndCorrelated noise weightings drift with time, in order to simulate a typical noisy environment. This is especially useful for testing the adaptive spatial filter. Note that if the drift rate is very high, then the noise reduces to simple NonCorrelated noise.

The 3D plot shows the net result of the noise selections. In order to emulate data in the same format as RealTime data, the simulation is done in large blocks of time (typically 4096 datapoints long). The 3D plot shows only a particular index of this block, which can be adjusted by the user via the slidebar.

4.2.6 – RawData tabset >> Data Source >> Channels >> PlayBack

The user can select a RawData.bin file for PlayBack. Toggling the yellow “Active” switch to ON will initiate recording. The PlayBack can be prematurely terminated by switching to off.

A typical way of using the PlayBack option is to record a set of raw data with no processing, and then use PlayBack to do heavy processing and save the result. To do this, the user first switches the Data Source to RealTime, then switches Raw Recording on. Live data gets saved to disk in a RawData.bin file. Next, after the data is saved, the user configures whatever processing is desired, switches to PlayBack, and then switches Raw Recording on. At this point, no data will be recorded because no data is streaming through the system. When the user selects a RawData.bin file and toggles the PlayBack Active switch, then the file data will begin streaming through the system and be processed and recorded.

It should be evident that the user can repetitively PlayBack and Record a set of data many times. The history of this process is automatically summarized in the Comments field of the RawData.bin file, and any user comments are accumulated.

4.2.7 – RawData tabset >> Data Source >> Polaris

The Polaris data is only available in RealTime mode.

4.6.0 – RawData tabset >> Filtering

There are three types of filters available to the user: Decimation, Spatial, and Temporal. They are applied in that order, and all data clients (such as the StripChart, Trigger-based Averaging, and Recording) are affected.

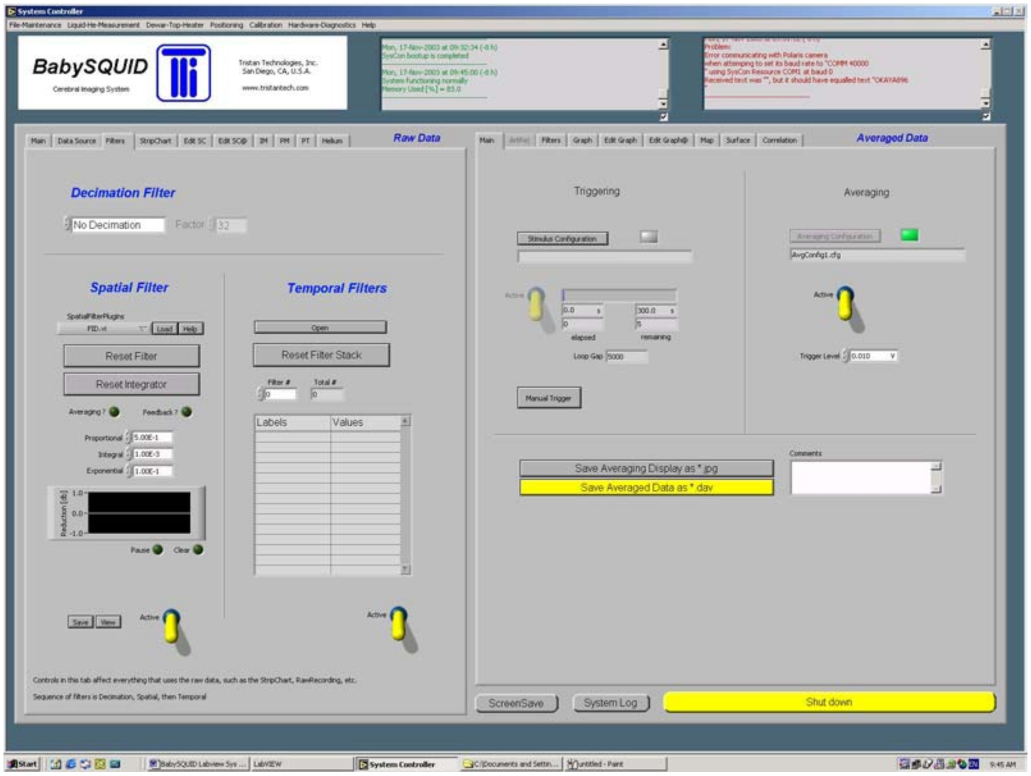

Figure 16: RawData Filtering

4.6.1 – RawData tabset >> Filtering >> Decimation Filter

Incoming raw data (whether RealTime, PlayBack, or Simulation) can be decimated (with or without averaging). If averaging is used, a block averaging algorithm is used, not a box-car. This averaging is not to be confused with trigger-based averaging, which is what the entire right-side of the SysCon display is for.

4.6.2 – RawData tabset >> Filtering >> Spatial Filter

These filters are for removing correlations between channels of the raw data stream. Because there is so much variability in the design of such filters, they are employed as plug-in modules. The user is free to write their own modules (based on a template), and place it in the spatial filter directory. During SysCon operation, the user sees a listing of the available spatial filter plug-ins that are present in the spatial filter directory.

The template to use is located in the spatial filter directory, and is called Template.vi. A user-written spatial filter must have the extension .vi, and any of its sub-VIs must be in a .llb file of the same name. A help file should also be written, having the same name but with extension .txt.

The spatial filter provided by Tristan is called PID.vi. It assumes the tensor array data is purely noise, so it uses that data to remove correlated noise from the SQUID channels. Correlation between SQUID channels themselves is not used.

4.6.3 – RawData tabset >> Filtering >> Temporal Filters

These filters are for removing particular frequency components of a raw data stream. A fairly detailed panel is available for building such filters, as shown in **Figure 17**.

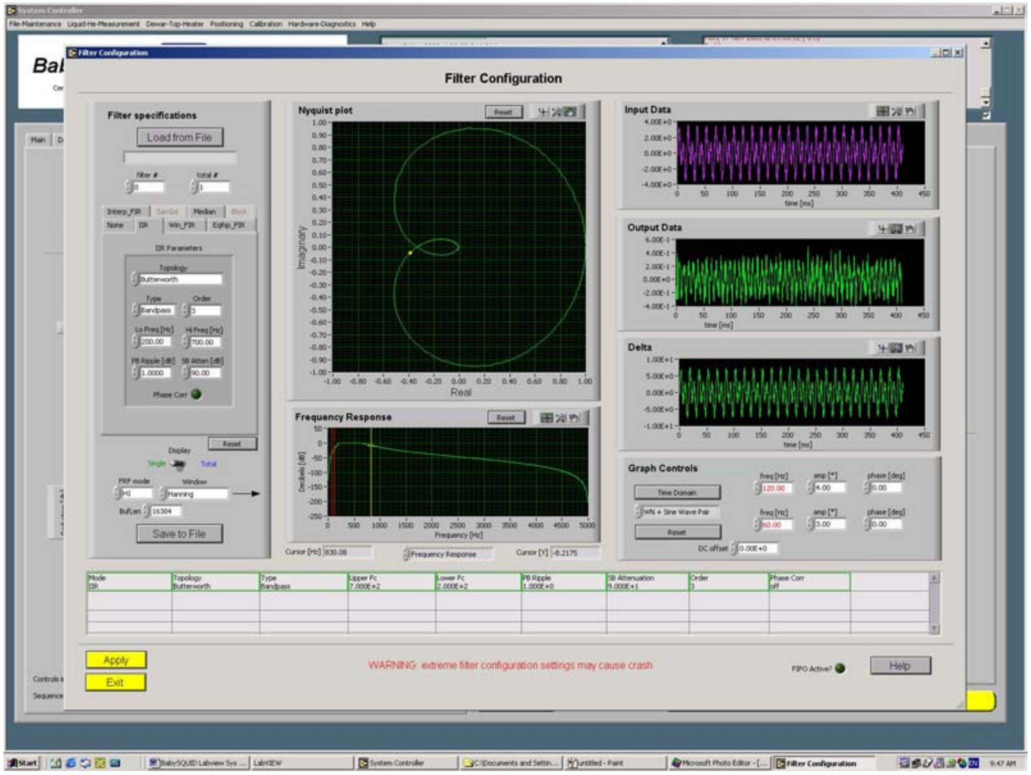

Figure 17: RawData Temporal Filtering

The various filters available, and their controls, are located on the left under Filter Configuration. Available filter types are IIR, Windowed FIR, Equi-Ripple FIR, Interpolated FIR, and Median. Savitzky-Golay and Block filters have been disabled. The filters can be sequentially stacked, but in this version of the filter software, the user is limited to a stack length of 1. The Reset button is the re-initialize the analysis of the filter characteristics; this is sometimes necessary when switching between filter types.

The filter parameters are range limited in order to prevent the user from selecting inappropriate or excessive settings, and some simple logic has been implemented to otherwise prevent the user from selecting nonsense combinations of settings. Despite these precautions, it is still possible for the user to select some nonsense combinations of values, especially with the Equi-Ripple FIR and Interpolated FIR filters. If there is no display of the filter behavior, try adjusting the settings. Also, be aware that some combinations of settings can cause the software to crash, so the user should exercise caution when experimenting with filter settings.

The center displays show the filter characteristics. White noise, rather than a frequency scan, is used because of its better computational efficiency. The Nyquist plot shows the Real vs Imaginary components, and the lower graph shows either Frequency Response or Coherence. The yellow cursor can be grabbed and dragged, and a corresponding cursor will move on the upper Nyquist plot.

On the right are displays that show the actual effect on data. The data used can be selected to be either White Noise, White Noise plus Sine Wave Pair, Sine Wave Pair, or Live Data. The Live Data selection is for the raw data; the others are to assist the user with filter experimentation.

The Reset button does an autoscale of the X and Y axes; this is frequently necessary when changing filter and display settings.

Note: in order for the filter(s) to be applied, the user must switch on the FilterActive? button in the StripChart tab.

4.7.0 – RawData tabset >> StripChart

This shows a RealTime, PlayBack, or Simulated data stream. Below the strip chart are various controls for setting the X and Y scales, zooming, and changing the display mode (scope or sweep).

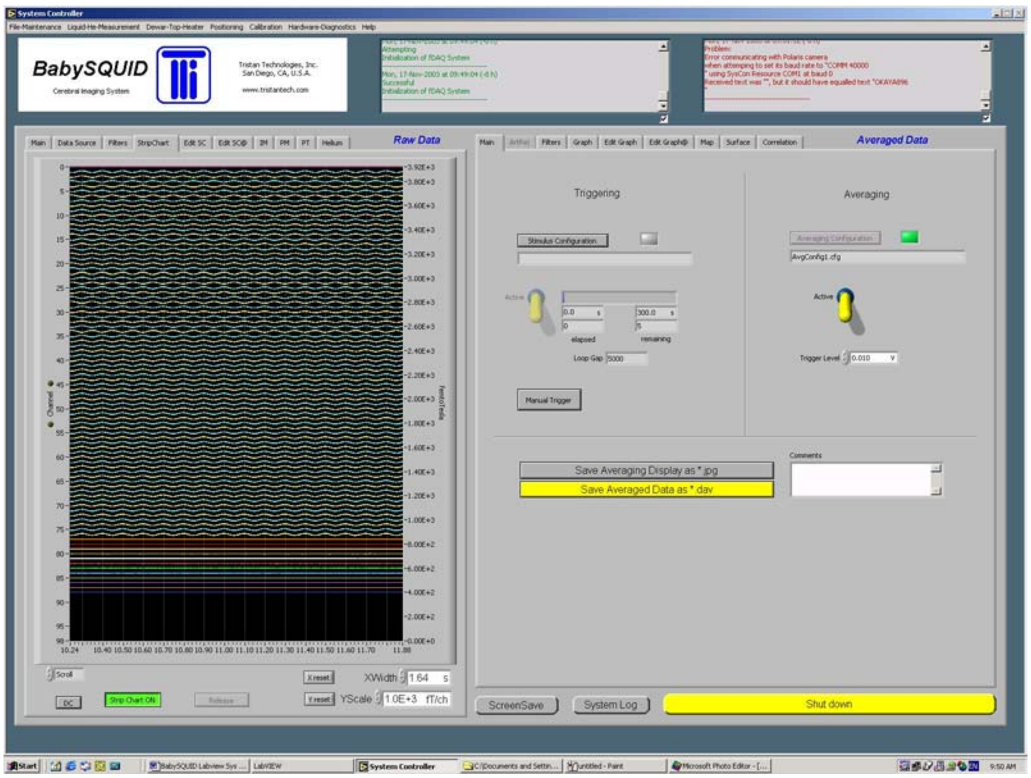

Figure 18: StripChart

This strip chart requires heavy use of the SysCon processor, and so it is recommended that the user leave this display off unless needed.

4.8.0 – RawData tabset >> Edit SC

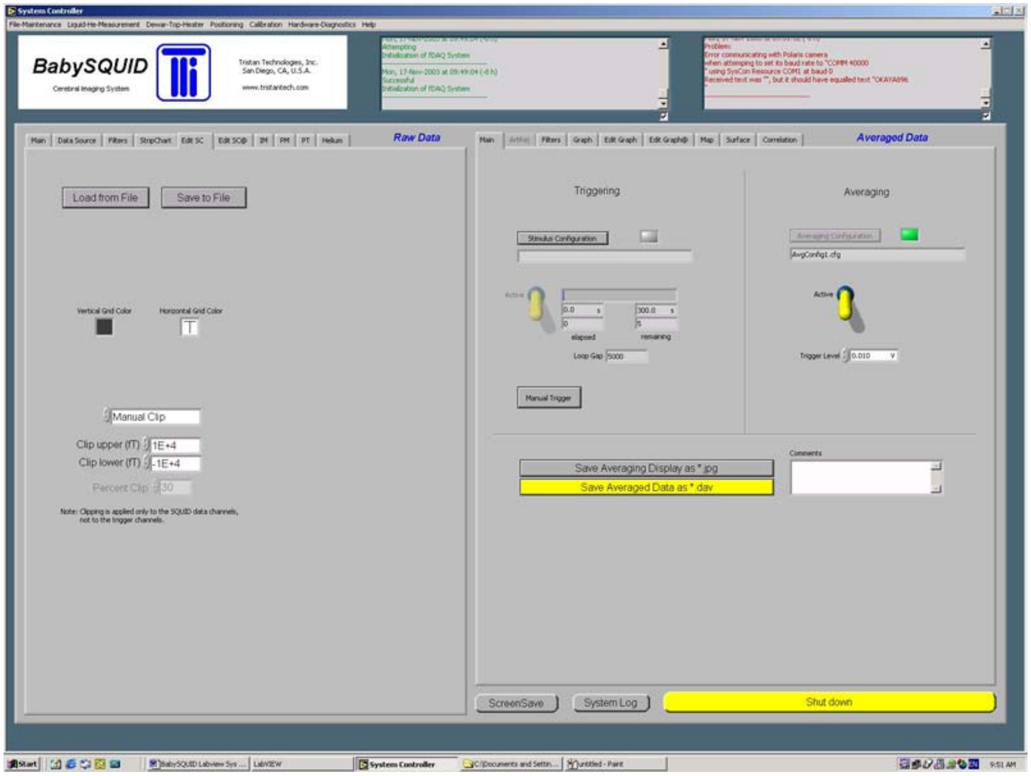

Figure 19: Edit StripChart

These controls are for the entire StripChart. The Load and Save file are for the controls on this tab and also the Edit SC@ tab (see below).

4.9.0 – RawData tabset >> Edit SC@

This enables the user to control specific traces. The user is allowed to change trace visibility and color , which is useful when one signal overlays other, weaker signals. The other parameters in the table are set by the calibration files (located in the Main Config directory) during initialization.

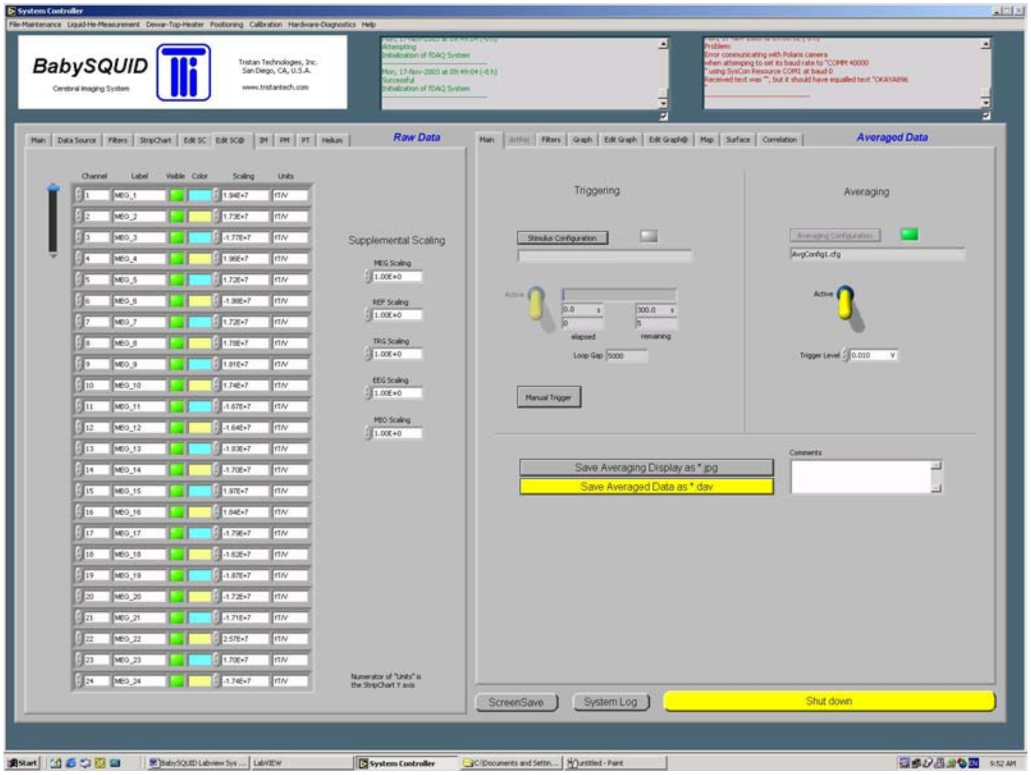

Figure 20: Edit StripChart@

The Supplemental Scaling controls allow the user to compensate the Y-scale for the disparate types of signals shown together on the stripchart, so that all data can be properly scaled at the same time.

4.10.0 – RawData tabset >> Image Mapping

The user can generate a map of the subject's head by using a photographic technique, whereby a flash unit projects a shadow grid onto the subject, while an off-axis camera takes a photograph. The resulting image will show distortions in the grid due to subject topography. By processing this image using the Eyetronics software utility, the 3D topography of the subject can be extracted and saved into a *.obj file. When doing subject mapping by this method, it is not necessary to have the HeadTool affixed to the subject (see Polaris Mapping and Polaris Tracking sections).

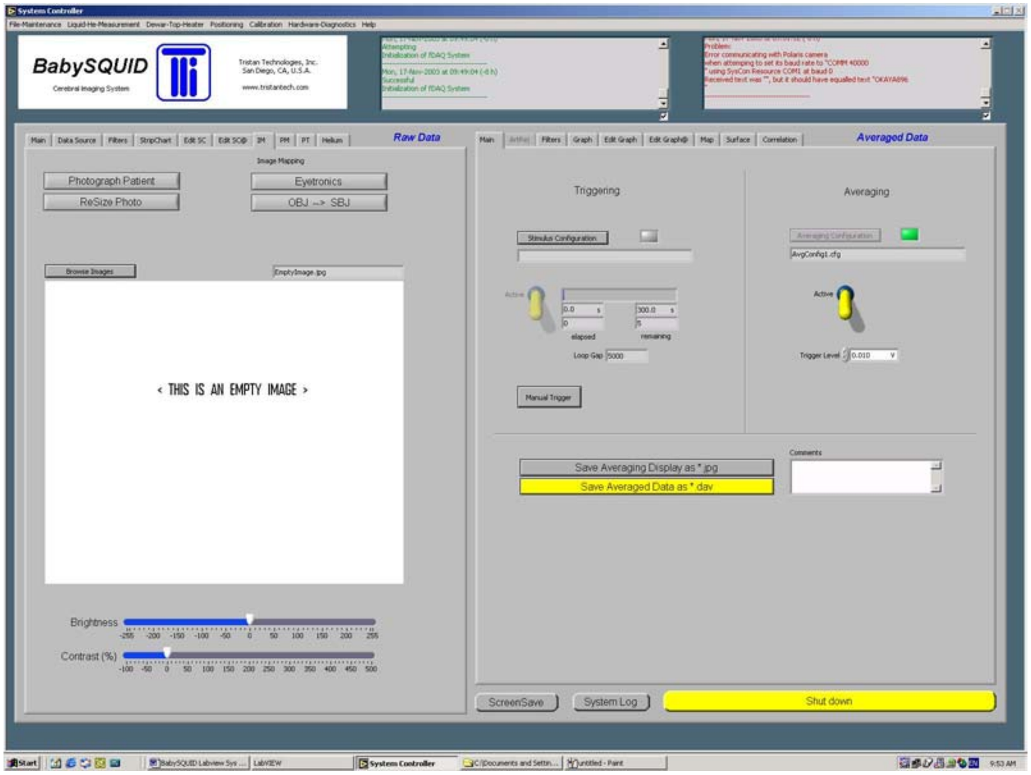

Figure 21: Image Mapping

4.10.1 – RawData tabset >> Image Mapping >> Photograph Subject

Photograph Subject opens the Canon *PowerShot Pro90 IS* software utility, for taking photographs of the subject, as shown in **Figure 22**.

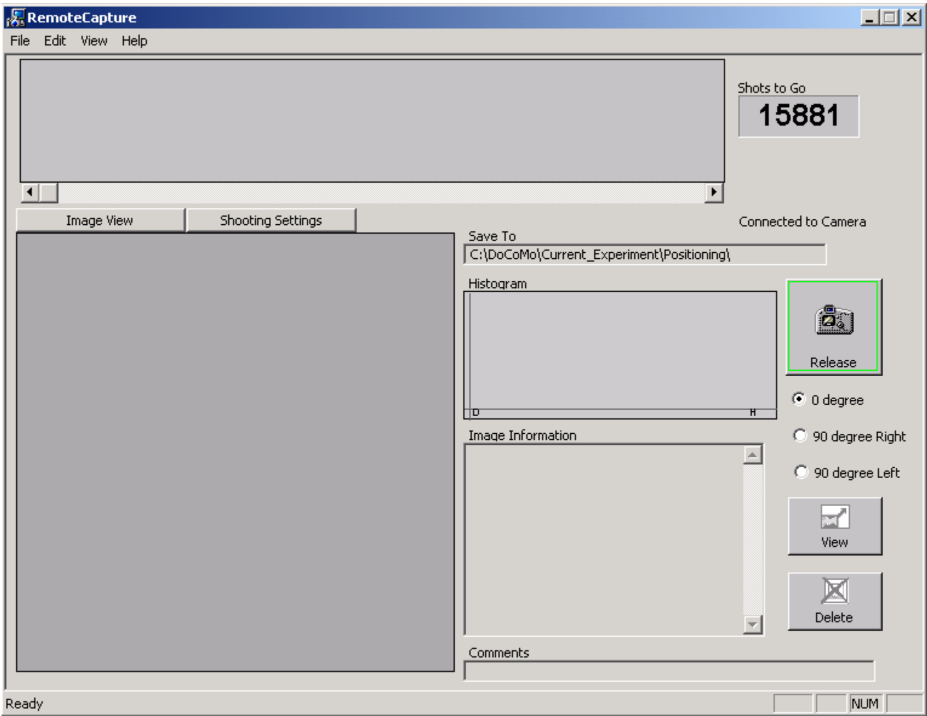

Figure 22: Photograph subject

The subject is positioned in front of the camera, in the same general vicinity as where the camera calibration was performed (see camera manual). Photographing the subject outside of this region will result in significant topological distortions. If a whole-head image map of the subject is desired, then a series of photos will need to be taken, from different angles. Stitching the resulting *.obj files together can be done using ShapeMatcher, and usually takes several hours of manual labor.

Generally, the user will move the zoom slider to an intermediate position, take a few test shots, then "Release" to take and download the proper photo from the camera to SysCon under a ~/ExperimentData/Project/Subject/Date/*_Photos directory tree, where the ~ root directory is specified by the user in MainConfig.ini (or other user-selected *.ini file).

Caution: the user must let the Flash Charger rest for a minimum of 30 seconds between flashes, otherwise the unit will burn out very quickly.

4.10.2 – RawData tabset >> Image Mapping >> ReSize Photo

ReSize Photo opens the MicroSoft Windows *Photo Editor* software utility, as shown in **Figure 23**.

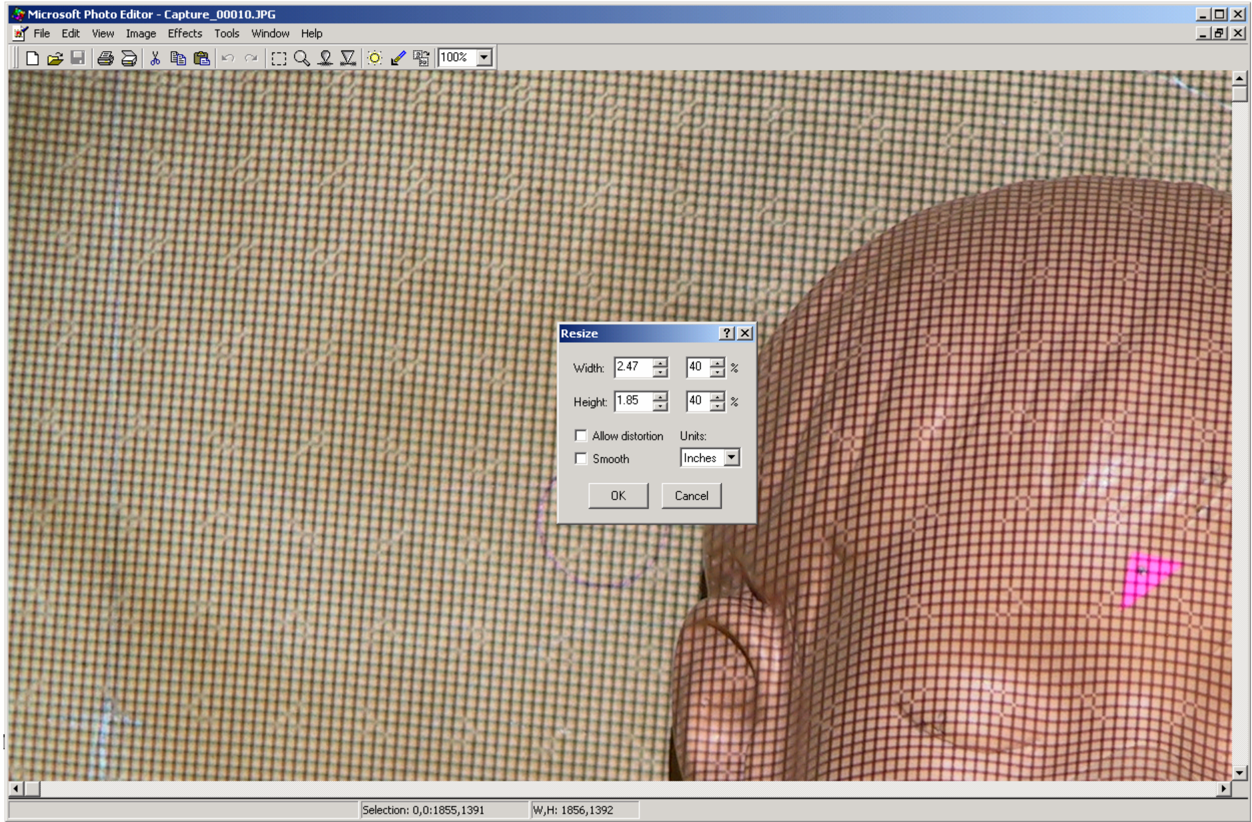

Figure 23: Photo Re-size

Generally, the user should not need to alter the image size. However, this utility is provided in case the user needs it for a specialty application.

4.10.3 – RawData tabset >> Image Mapping >> Eyetronics

Eyetronics opens the Eyetronics *ShapeSnatcher* software utility, as shown in **Figure 24**.

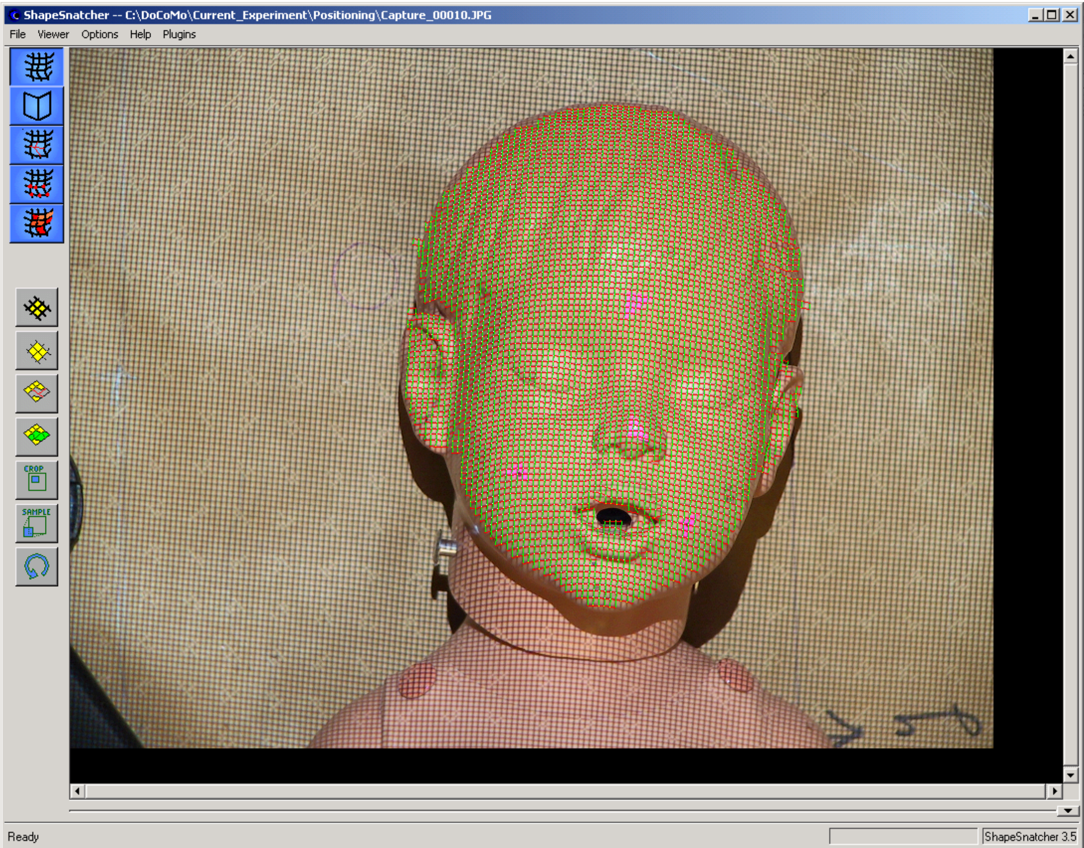

Figure 24: Grid Extraction

The photo is loaded, and the grid extracted, by using the various controls. For detailed instructions, please refer to the second part of the Optical Mapping and Positioning manuals, and the Picture Processing Procedure for Mapping manual.

After finishing the grid extraction, the user should save both a *.obj file (a simple ASCII file that contains X,Y,Z coordinates and normal vectors), and a *.ss3d file (a file that contains grid display information, specific to Eyetronics). These files should be saved under a ~/ExperimentData/Project/Subject/Date/*_SurfaceGrd directory tree, where the ~ root directory is specified by the user in MainConfig.ini (or other user-selected *.ini file).

Then, the user does Plug-ins → Coordinate info and saves the 3 fiducial markers as 3 separate files: C:\BabySQUID\Current_Experiment\Positioning\GridRef1.xyz, ~\GridRef2.xyz, and ~\GridRef3.xyz. These files should be saved under a ~/ExperimentData/Project/Subject/Date/*_SurfaceGrd directory tree, where the ~ root directory is specified by the user in MainConfig.ini (or other user-selected *.ini file).

4.10.4 – RawData tabset >> Image Mapping >> OBJ -> SBJ

The OBJ file that is generated must be converted to an SBJ file in order to be displayed by SysCon. The user selects a particular OBJ file along with its set of three XYZ files, and an SBJ file is then generated in the same directory location.

4.10.5 – RawData tabset >> Image Mapping >> Display of images

The user can browse and display any *.jpg file here.

4.11.0 – RawData tabset >> Polaris Mapping

The user can generate a map of the subject's head by using the Polaris stylus, whereby the user affixes a HeadTool to the subject's head and traces the stylus tip along the skin surface. The stylus is also used to define the locations of the 3 fiducial markers. The resulting data is used to calculate the head shape in both the HeadTool and Fiducial (Subject) coordinate frames.

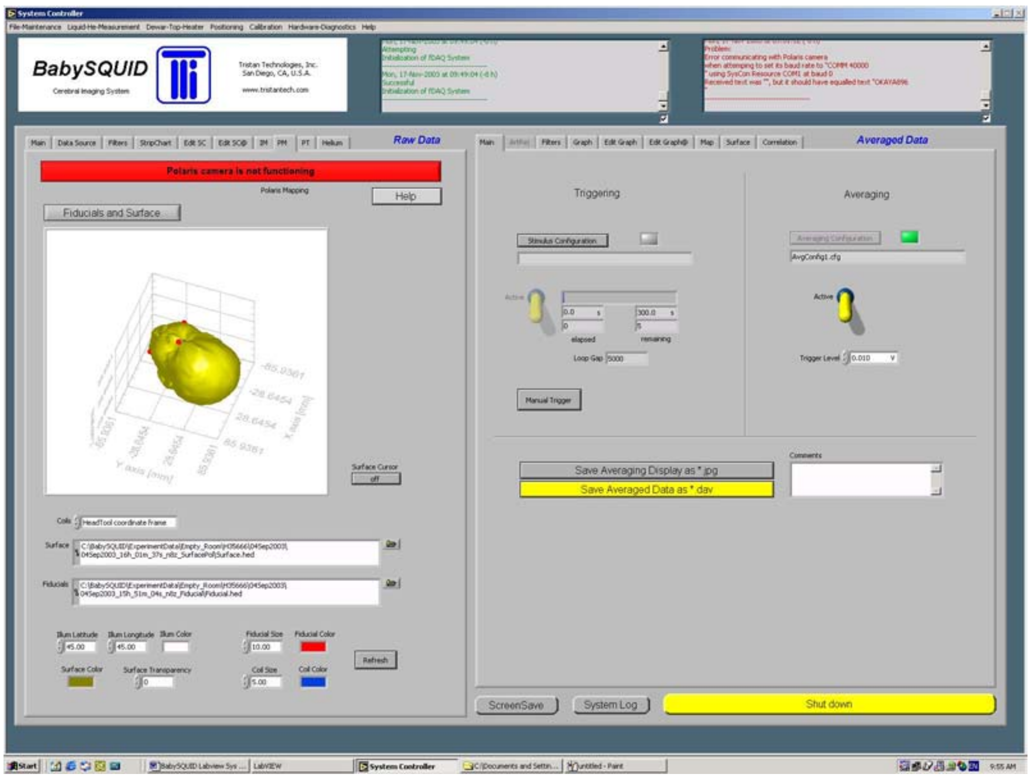

Figure 25: Polaris Mapping

4.11.1 – RawData tabset >> Polaris Mapping >> Fiducials and Surface

Fiducials and Surface opens the Polaris marker and mapping utility, as shown in **Figure 26.**

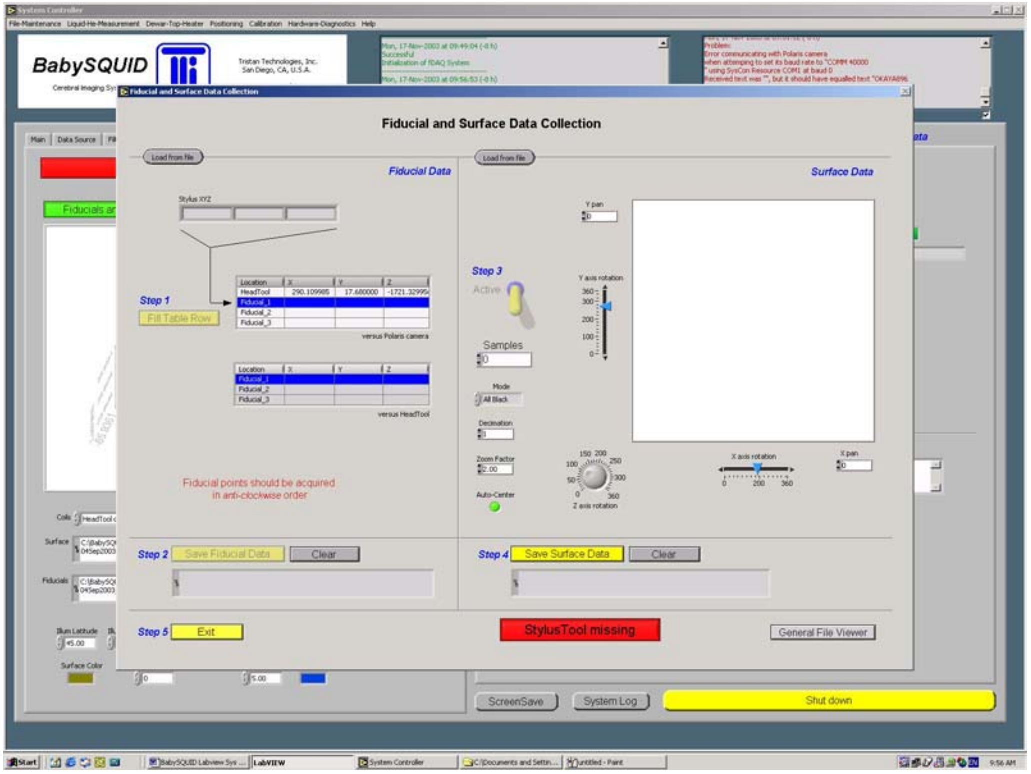

Figure 26: Fiducials and Surface

Note: the “ToolSettings.txt” file defines which tools and in what order the Polaris generates positioning data.

Both the HeadTool and the StylusTool must be visible to the Polaris camera, as indicated by a lack of red warning labels and the appearance of data in the Stylus XYZ indicator. The user simply places the stylus tip at Fiducial marker #1, and has an assistant highlight (dark blue) the second line of the “versus Polaris camera” and press the Step 1 “Fill Table Row” button. This will copy data from the “Stylus XYZ” indicator into the “versus Polaris camera” table, and calculate a corresponding row in the “versus HeadTool” table. This process is repeated for the remaining two fiducial markers to fill in the remainder of the table. The end result is that both tables are filled with data.

Pressing the Step 2 “Save Fiducial Data” button saves the table data as Fiducial.hed and Fiducial.sbj files. These files are located under a ~/ExperimentData/Project/Subject/Date/*_Fiducial directory tree, where the ~ root directory is specified by the user in MainConfig.ini (or other user-selected *.ini file).

Pressing the Step 3 “Active” button begins writing point data to the 2D display whenever the StylusTool is visible to the Polaris camera. The user should cover the StylusTool with their hand, toggle the “active” switch on, bring the StylusTool tip to the subject’s skin, uncover the StylusTool, and begin tracing over the skin surface. This accumulates a series of points that are displayed in the 2D graph. The graph can be rotated and monitored by an assistant to ensure that there are no large sections of un-mapped surface. The tracing pattern used is immaterial. Also, it does not matter if the subject is moving during the tracing procedure, since the data points are determined relative to the HeadTool.

Point accumulation can be paused by simply covering the StylusTool with a hand, to allow free movement by the user. If a mistake is made, the user can edit the “Samples” field to reduce the dataset to the last good data. Generally, 2000 to 3000 samples constitutes a recognizable head shape, if the user gives special attention to defining features such as nose, ears, and eyes.

Pressing the Step 4 “Save Surface Data” button saves the mapping data as Surface.hed and Surface.sbj files. These files are located under a ~/ExperimentData/Project/Subject/Date/*_SurfacePol directory tree, where the ~ root directory is specified by the user in MainConfig.ini (or other user-selected *.ini file).

4.11.2 – RawData tabset >> Polaris Mapping >> Display Mapping & Tracking

The user selects Surface.hed/Surface.sbj and Fiducial.hed/Fiducial.sbj files, and this data is then displayed in a 3D graph. Superimposed on this is a real-time display of the coil locations that are tracked during an experiment. The user can choose between either the HeadTool or Fiducial (Subject) coordinate frames.

Note: the HeadTool must be affixed to the subject’s head in the same place throughout both mapping and tracking. If the user wishes to move the HeadTool, then mapping must be repeated.

The 3D plot can be adjusted by the following operations:
<shift> + Lmouse == pan
<ctrl> + Lmouse == rotate
<alt> + Lmouse == zoom

Various controls allow the user to control parameters for the surface illumination, point sizes, and colors. A cursor is available for manually extracting point data.

The primary purpose of this display is ensure that the entire positioning system is properly functioning.

4.12.0 – RawData tabset >> Polaris Tracking

A table shows the tracking status for all three tools (StylusTool, HeadTool, and BedTool). If a tool is not visible to the Polaris camera, all the values in that row will be zero.

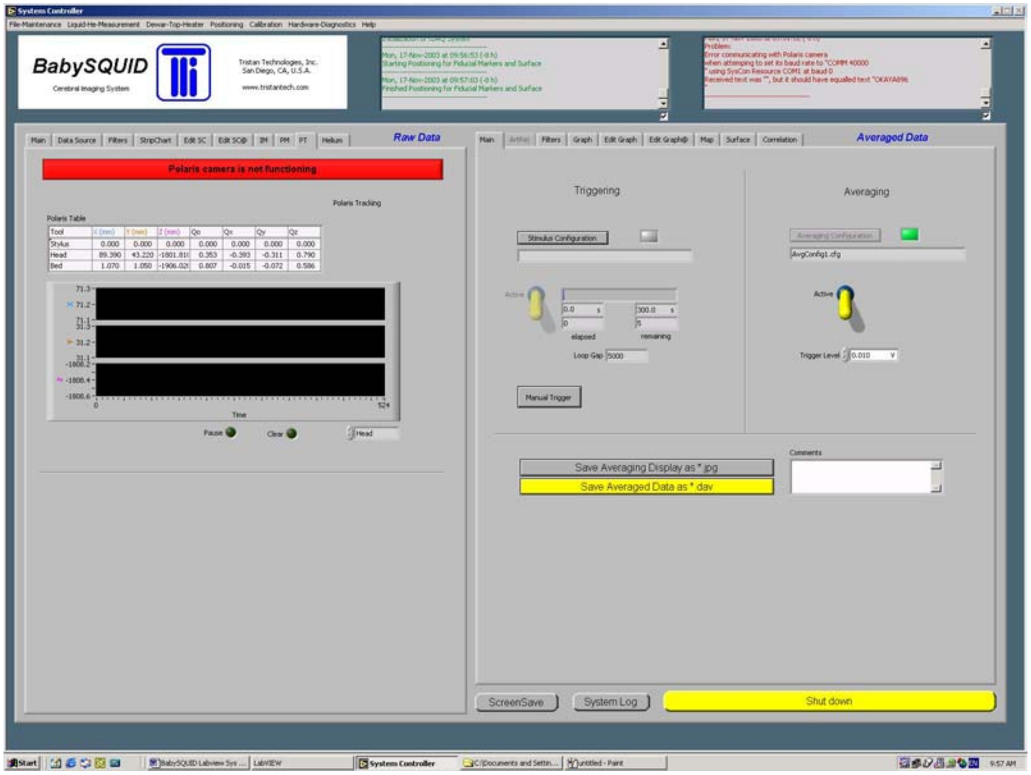

Figure 27: Polaris Tracking

The set of three graphs shows the X, Y, and Z values for a particular tool over time. If the graph is paused, then the Graph Palette becomes visible, enabling the user to zoom, pan, and scroll backwards in time. This is to monitor quiescent tracking epochs.

4.13.0 – RawData tabset >> Helium

The *Approx Liquid He Days Remaining* meter indicates the approximate number of days remaining before the Dewar runs completely out of liquid helium. This meter indicates a calculated value based on the last liquid helium level measurement (see the Liquid-He-Measurement panel accessible from the menu bar of the System Controller panel) and the approximate boil-off rate set in this panel. The days remaining are only an approximation; the level should be regularly measured once the indicated reading is below ~ 1.5 days. The level arrow on this meter will flash when the meter indicates that less than 0.5 days remain before a helium transfer will be necessary; it is recommended to promptly transfer helium when the level gets this low.

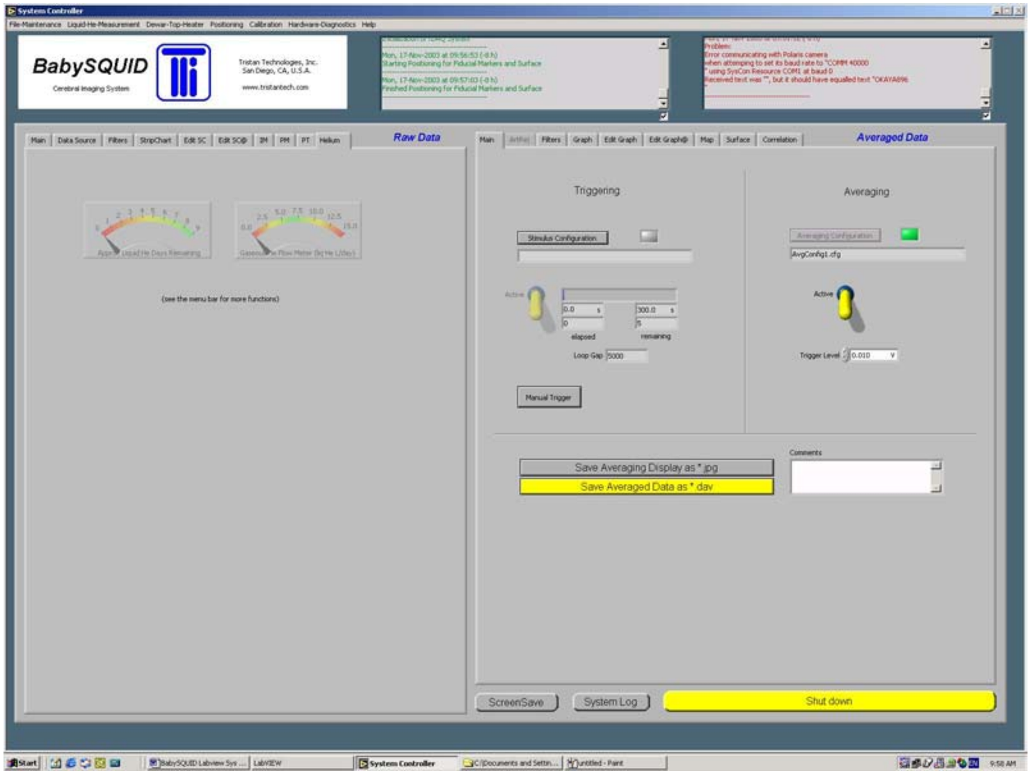

Figure 28: Helium

The *Gaseous He Flow Meter* indicates the helium boil-off rate as calculated based on the instantaneous flow rate of the boiled off helium gas. The gas flow rate is converted to an equivalent liquid helium liters per day value.

5.0.0 – Averaged Data tabset

This set of tabs is for configuring, displaying, and saving the trigger-based averaged data stream.

5.1.0 – Averaged Data tabset >> Main

This particular tab allows the user to do primary functions, such as triggering, averaging, loading, and saving trigger-based averaged data.

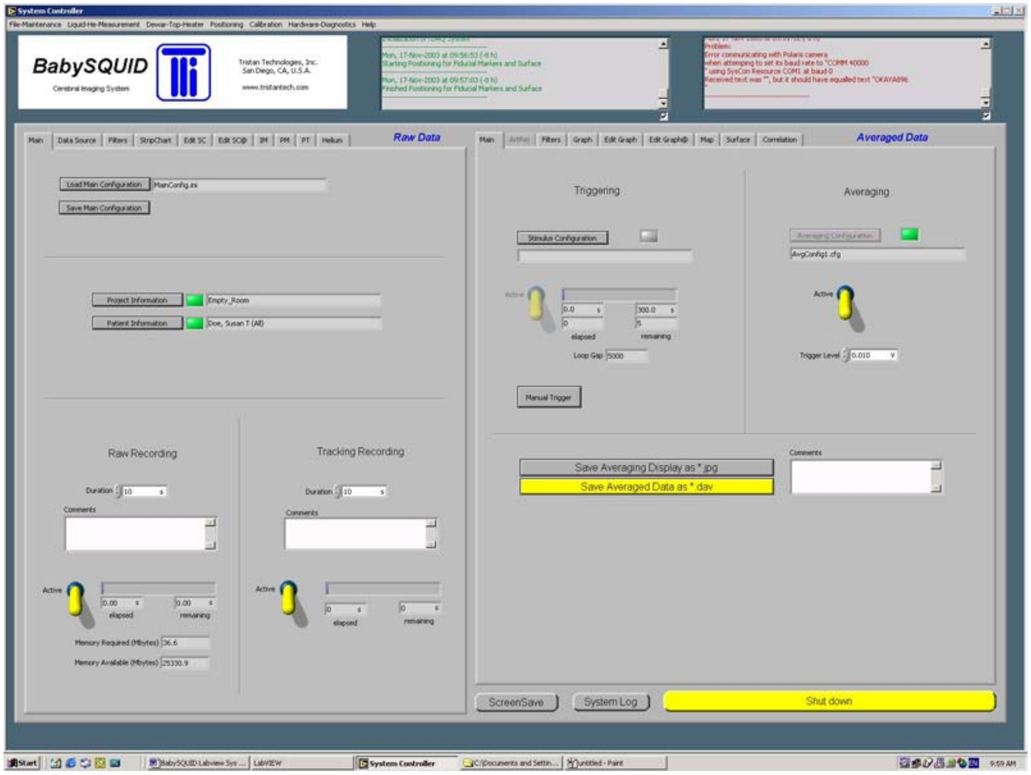

Figure 29: Averaged Data Main

5.1.1 – Averaged Data tabset >> Main >> Triggering

The *Stimulus Configuration* panel., selectable from the System Controller panel, is used when specifying the pattern of stimuli to be applied to the subject, as shown in **Figure 30**.

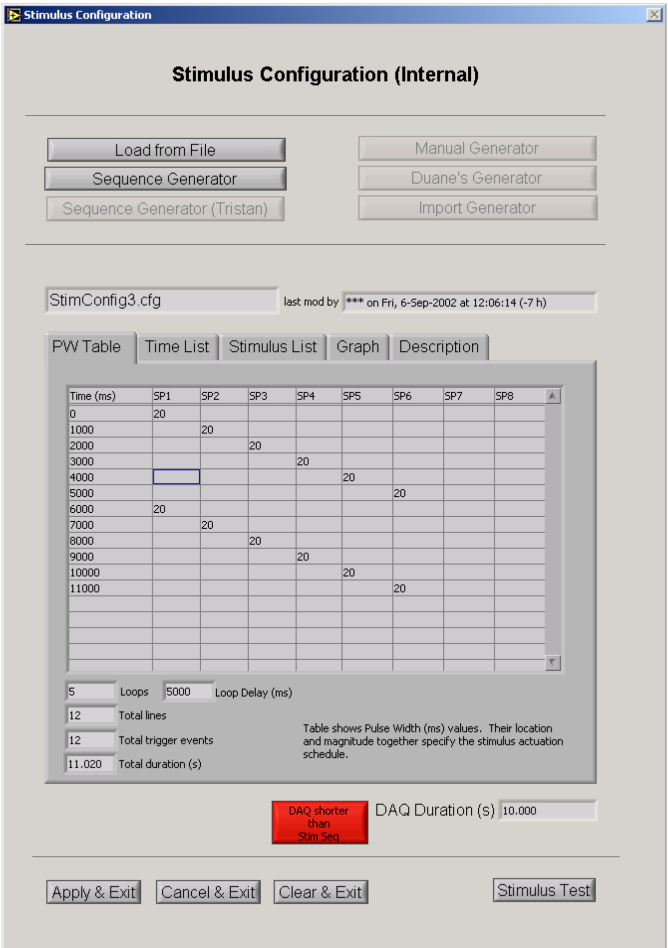

Figure 30: Stimulus Configuration (PW Table)

The system is provided with 8 trigger ports for use in stimulus generation (only 6 are accessible in the system as supplied). The timing and pulse width of the trigger signals are contained in a stimulus configuration file. There are two ways to load a stimulus configuration file for a data acquisition: load in an existing file, or generate a new file using the Neuromag-style sequence generator.

Using the *Load from File* button, an existing file can be loaded into the Stimulus Configuration panel. Once selected, information from the file appears in various formats in the lower part of the panel. The **PW Table** (Pulse Width) tab shows a table with the pulse widths for each trigger port along with the time during the acquisition when the trigger is initiated.

Pressing the *Apply & Exit* button will create the needed ICS trigger files, upload them to the ICS system, and print the selected sequence file on to the System Controller panel, also turning the Stimulus Configuration indicator panel green.

The ICS trigger files are of a special format, as specified in the ICS manuals. Each trigger has its own file.

The information displayed in the **PW Table** tab can be presented in several different ways, in order to assist the user. These additional tabs are described below.

The **Time List** tab shows each trigger along with the times when it is applied, as shown in **Figure 31**.

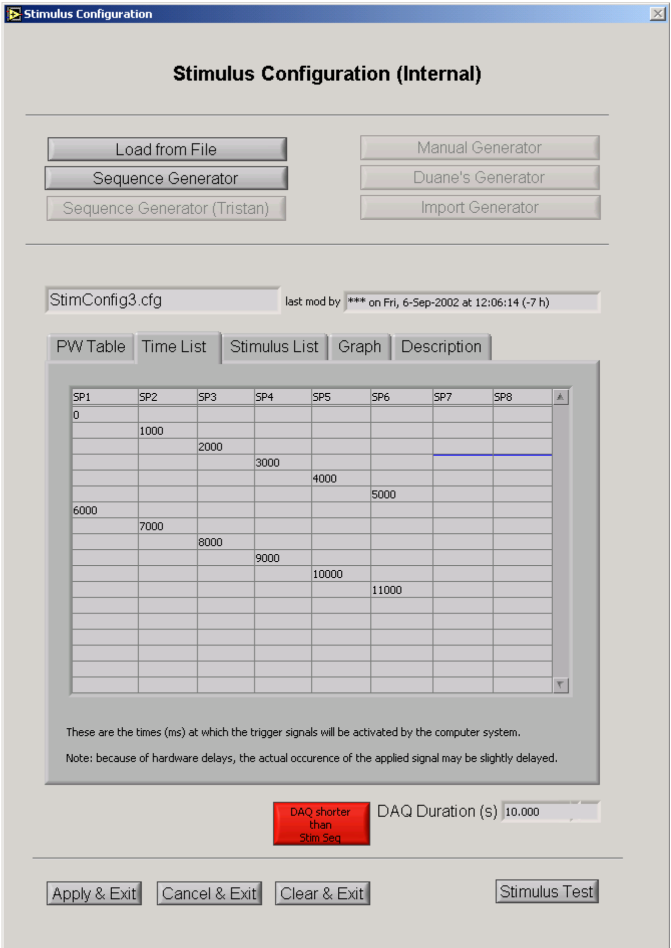

Figure 31: Stimulus Configuration (Time List)

The **Stimulus List** tab gives a sequential list of the triggers applied, along with their pulse width (PW), inter stimulus interval (ISI), and initiation times, in milliseconds, as shown in **Figure 32**.

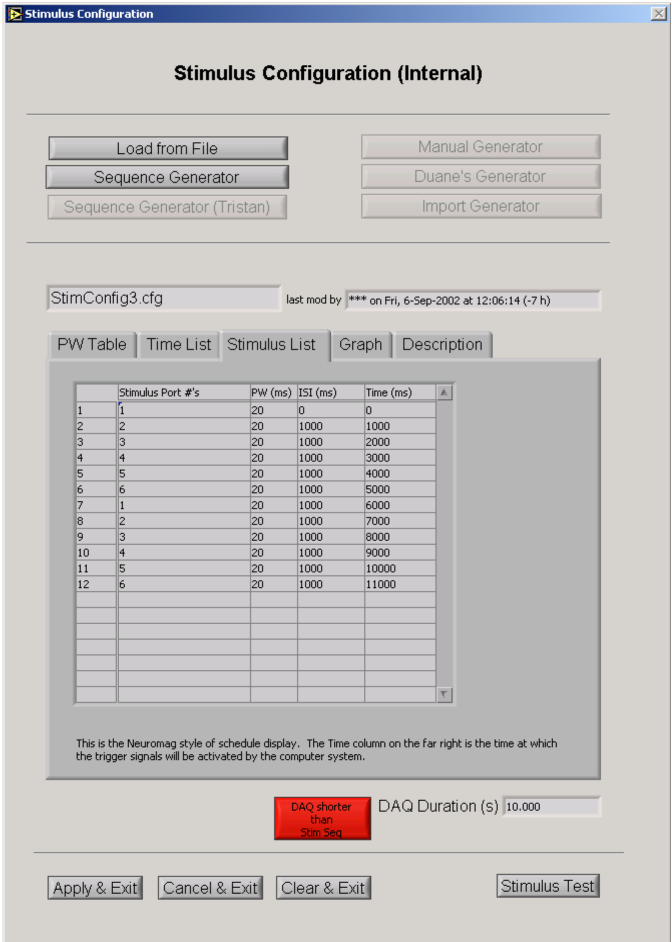

Figure 32: Stimulus Configuration (Stimulus List)

The **Graph** tab gives a graphical display of the stimuli, as shown in **Figure 33**.

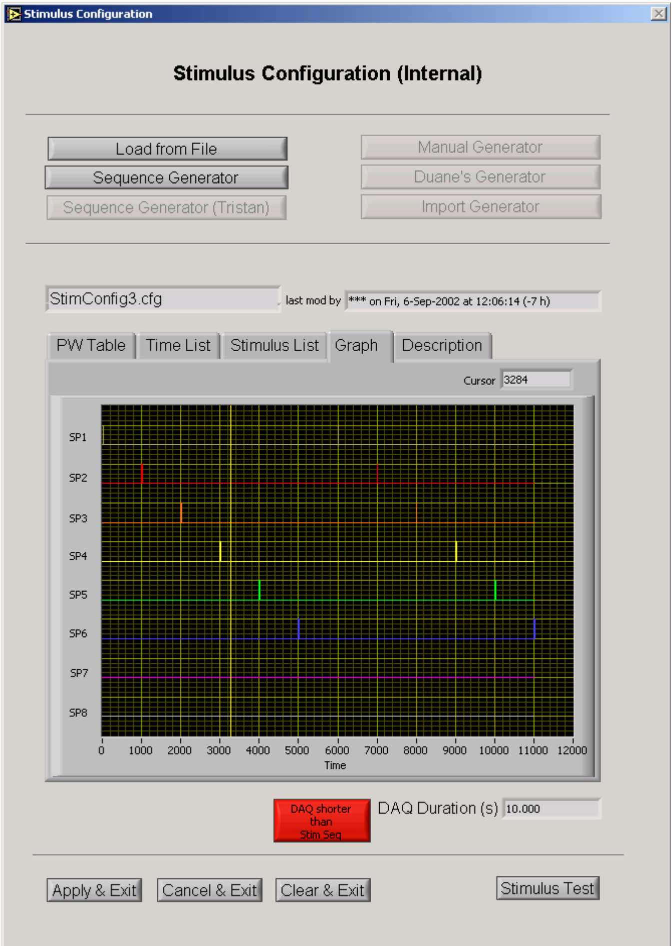

Figure 33: Stimulus Configuration (Graph)

Lastly, the **Description** tab show a text description associated with the stimulus configuration, as shown in **Figure 34**.

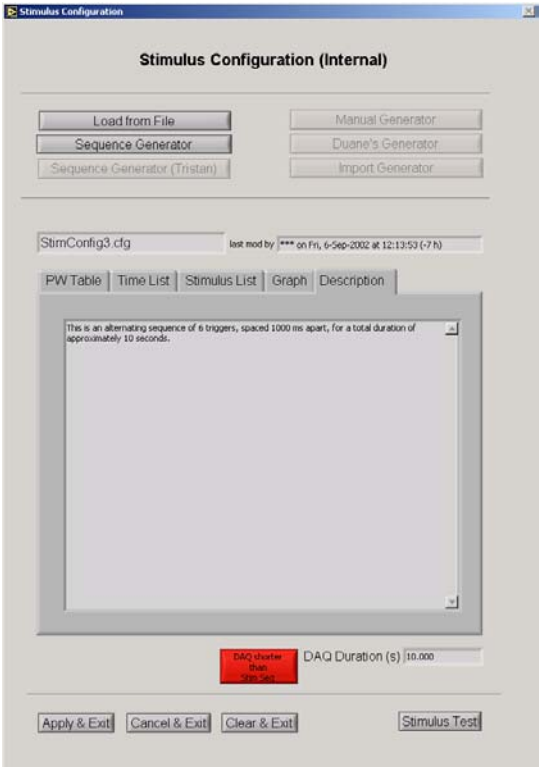

Figure 34: Stimulus Configuration (Description)

To generate a new stimulus file, press the *Sequence Generator* button on the Stimulus Configuration panel. This brings up the Stimulus Sequence Generator panel that provides generation capabilities based on that provided in Neuromag systems, as shown in **Figure 35**.

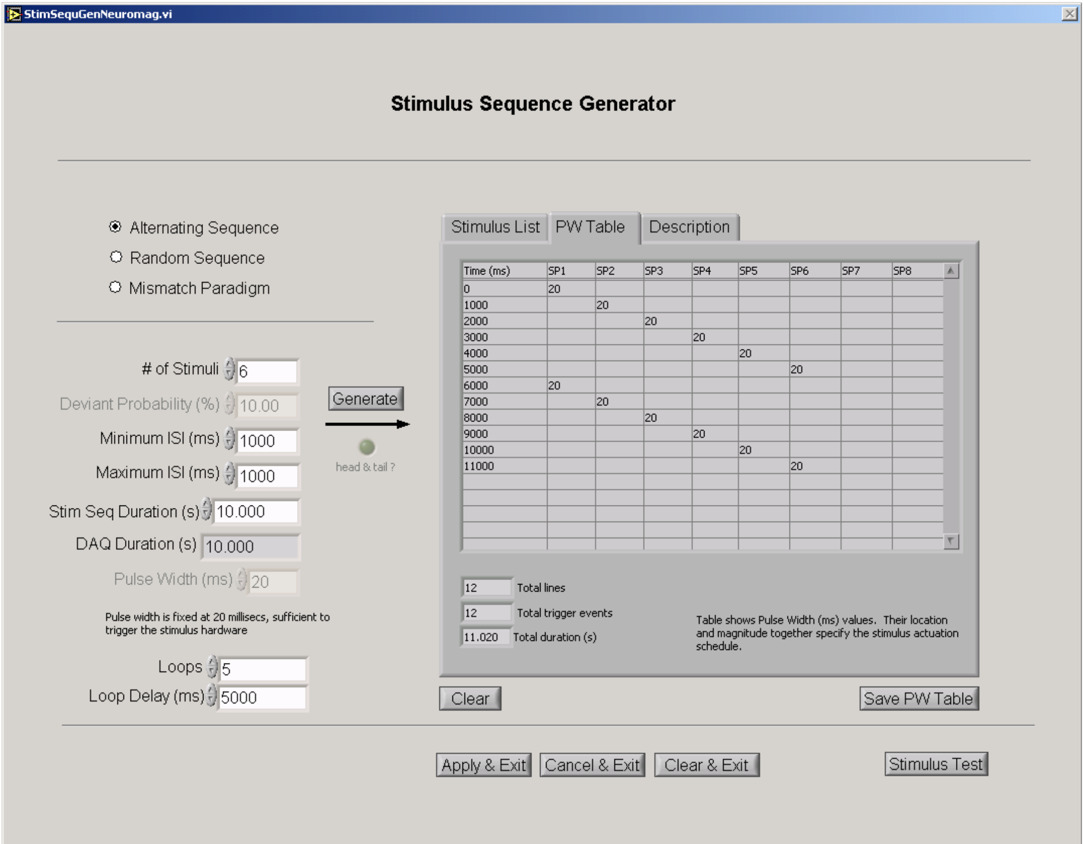

Figure 35: Sequence Generator (PW Table)

Three modes of sequence file generation are provided: Alternating sequence, Random sequence (equal probabilities), and Mismatch paradigm. For each mode, the user specifies the minimum ISI (inter-stimulus-interval) and maximum ISI. All trigger pulse widths are fixed at 20 msec.

1. Alternating sequence: The number of stimuli is specified in the range 1 to 6; then this number of stimuli is repeated sequentially. If the minimum and maximum ISI values are equal, then the ISI will be constant. If the two ISI values are different, then the ISI will vary randomly within the interval, with a uniform probability density.

2. Random sequence: The number of stimuli is specified in the range 1 to 6; then the stimuli are presented in a random sequence, each stimuli having an equal probability of occurring. The ISI is handled as indicated for the alternating sequence.

3. Mismatch paradigm: Here there are only two stimuli, and these two are triggered from trigger ports 1 and 2. Stimulus 2 is the deviant and occurs randomly in a monotonous sequence of stimulus 1 (standard) with the specified probability. If the deviant probability is less than 15% or greater than 85%, then two deviant stimuli will never occur sequentially. If the deviant probability is greater than 85%, then stimulus 1 is considered the deviant for this sequential rule. The ISI is handled as indicated for the alternating sequence.

Pressing the *Generate* button will generate the sequence table per the selections made, with the duration specified. When randomization is involved, repeated pressing of the *Generate* button will cause slightly different (randomized or shuffled) sequence files to be generated. Once satisfied with the sequence file, it may be named in the text window and saved using the *Save Table* button, both in the lower right portion of the panel. After generating and saving the sequence file, pressing the *Apply & Exit* button closes the Stimulus Sequence Generator panel, and delivers the table to the Stimulus Configuration panel.

The information displayed in the **PW Table** tab can be presented in several different ways, in order to assist the user. These additional tabs are described below.

The **Stimulus List** tab gives a sequential list of the triggers applied, along with their pulse width (PW), inter stimulus interval (ISI), and initiation times, in milliseconds, as shown in **Figure 36**.

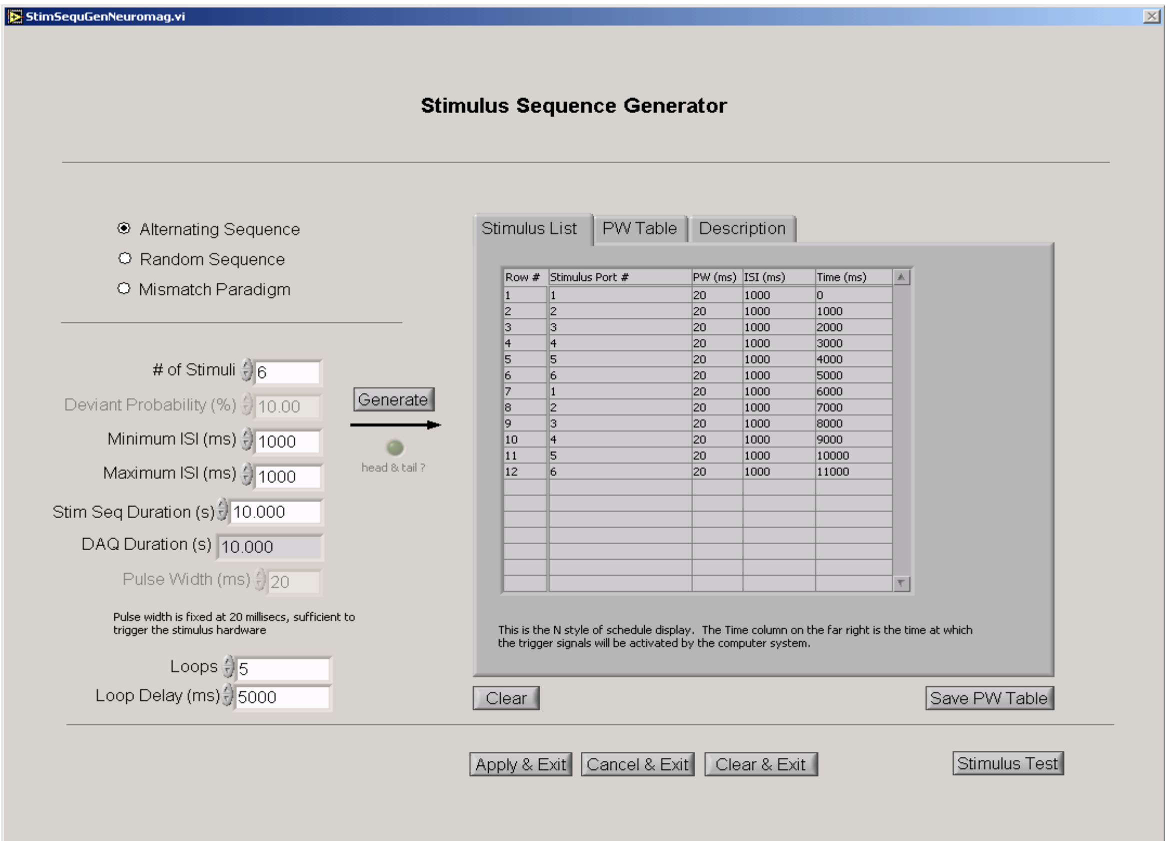

Figure 36: Sequence Generator (Stimulus List)

Lastly, the **Description** tab show a text description associated with the stimulus configuration, as shown in **Figure 37**.

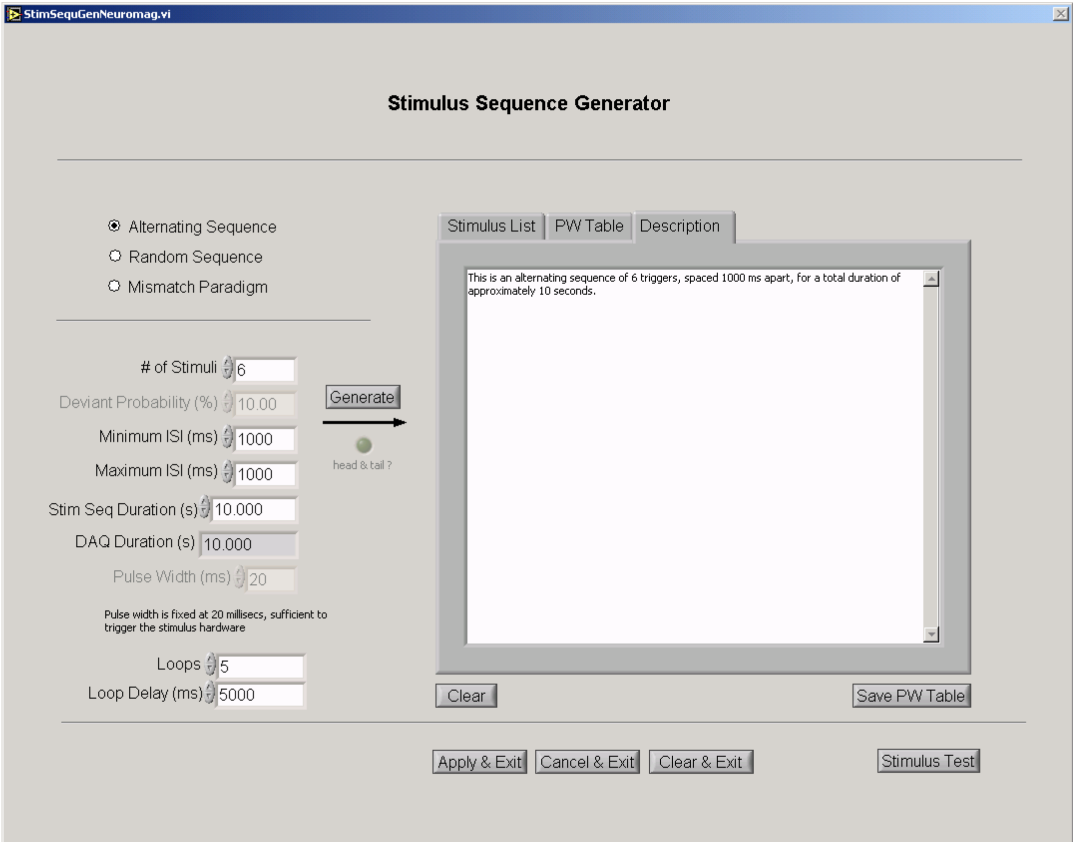

Figure 37: Sequence Generator (Description)

5.1.2 – Averaged Data tabset >> Main >> Averaging

The Averaging Configuration panel, selected from the System Controller panel, allows the user to set up different templates of stimulus events, which are to be compared to real-time stimulus data during an experiment. Upon a template match, all SQUID channel data in the temporal vicinity of the match is added to the template's averaging bin, which can be viewed in the Averaging Display (see below). Up to 10 stimulus templates, with associated averaging bins, may be defined. These 10 stimulus templates can be displayed as a Search Region (SR) table, as shown in **Figure 38**.

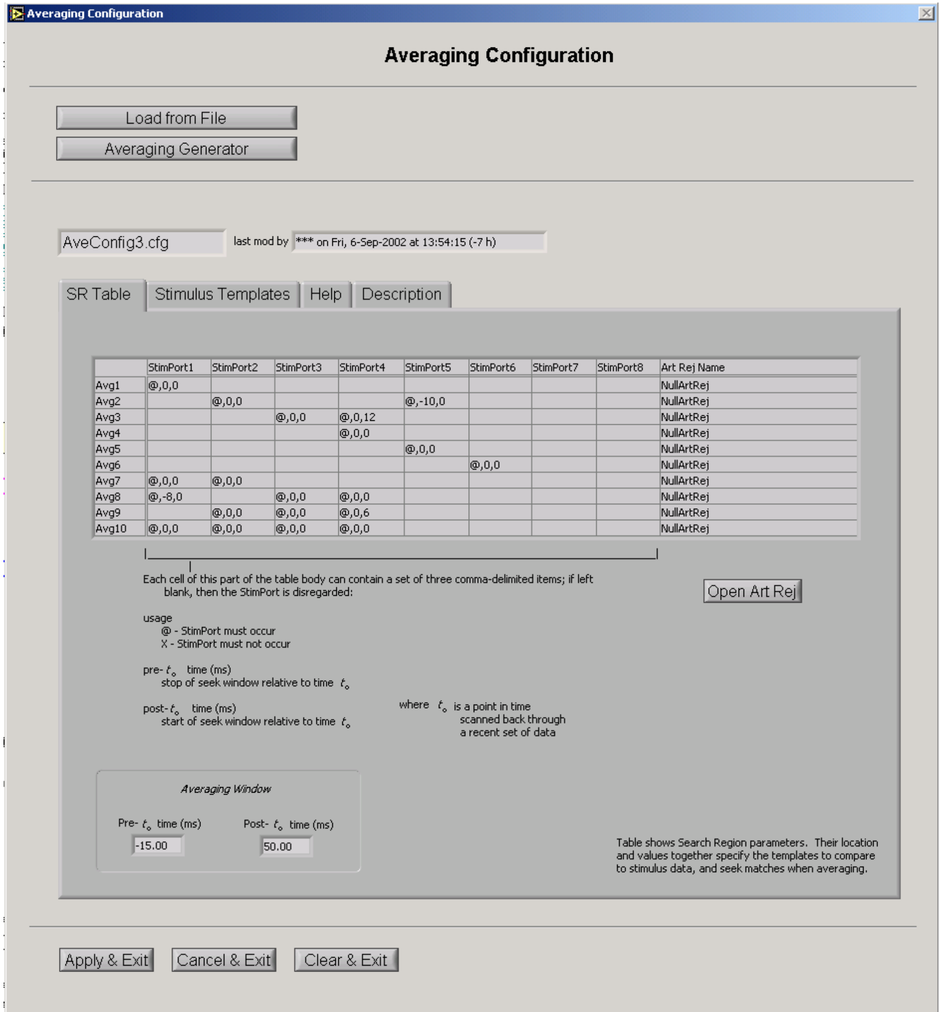

Figure 38: Averaging Configuration (SR Table)

Each cell of the table defines a Search Region (SR), which has 3 elements:

a) either an “@” or an “X”, to define whether the SR is Inclusion or Exclusion

b) a pre-t-zero value (ms)

c) a post-t-zero value (ms)

and each row forms a stimulus template.

Based on the contents of a row, a pair of stimulus templates is created as a 2D Boolean array, as shown in **Figure 39**.

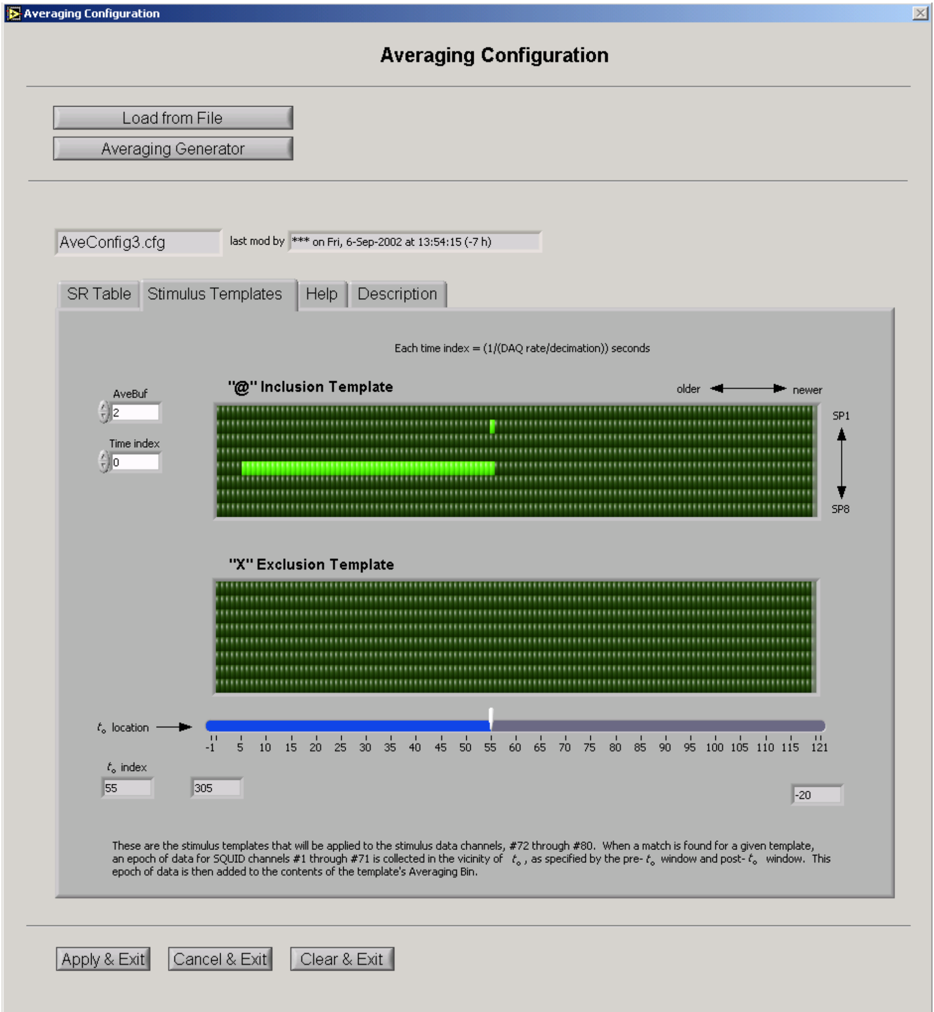

Figure 39: Averaging Configuration (Averaging Templates)

The upper template is for the Inclusion (@) cells, and the lower one is for the Exclusion (X) cells.

Note that each template has an index called "t-zero". This is located according the contents of the SR table row.

Also note that each non-empty cell of the SR table corresponds to a TRUE block in the template. The location of highlighted "TRUE" blocks for each stimulus port are given by the pre-t-zero and post-t-zero values.

As real-time stimulus data streams in, the templates are compared against the data, and slid along it for every point in time. As the Inclusion template is sliding along the data, the algorithm checks to see which of the TRUE blocks of the template contain at least one matching TRUE in the data. If, at some point in time, all TRUE blocks of the template contain at least one matching TRUE in the data, then there is a template match occurrence. Because the stimulus data is of finite duration, there will be a contiguous set of match occurrences. The earliest onset of these occurrences defines when an epoch of SQUID data in the temporal vicinity of it's t-zero is extracted and added to the template's averaging bin.

In the DoCoMo version of the software, the Exclusion logic has been disabled. If it were enabled, then if an SR table cell contains "X", then its template block must not contain any matching TRUE in the data.

The template information is contained in an averaging configuration file. There are two ways to load an averaging configuration file for a data acquisition: load in an existing file, or generate a new file using the Neuromag-style averaging generator.

Using the *Load from File* button, an existing file can be loaded into the averaging configuration panel. Once selected, information from the file appears in various formats in the lower part of the panel.

Pressing the *Apply & Exit* button will deliver the stimulus templates and print the selected sequence file on to the System Controller panel, also turning the Averaging Configuration indicator panel green. Pressing the *Cancel & Exit* button will exit the panel without making any changes on the System Controller panel. If the System Controller panel already has an entry under Averaging Configuration, pressing the *Clear & Exit* button will clear the entry on the System Controller panel.

Other tabs that are useful to the user are described below:

The **Help** tab shows presents a schematic showing how the various averaging parameters are defined, as shown in **Figure 40**.

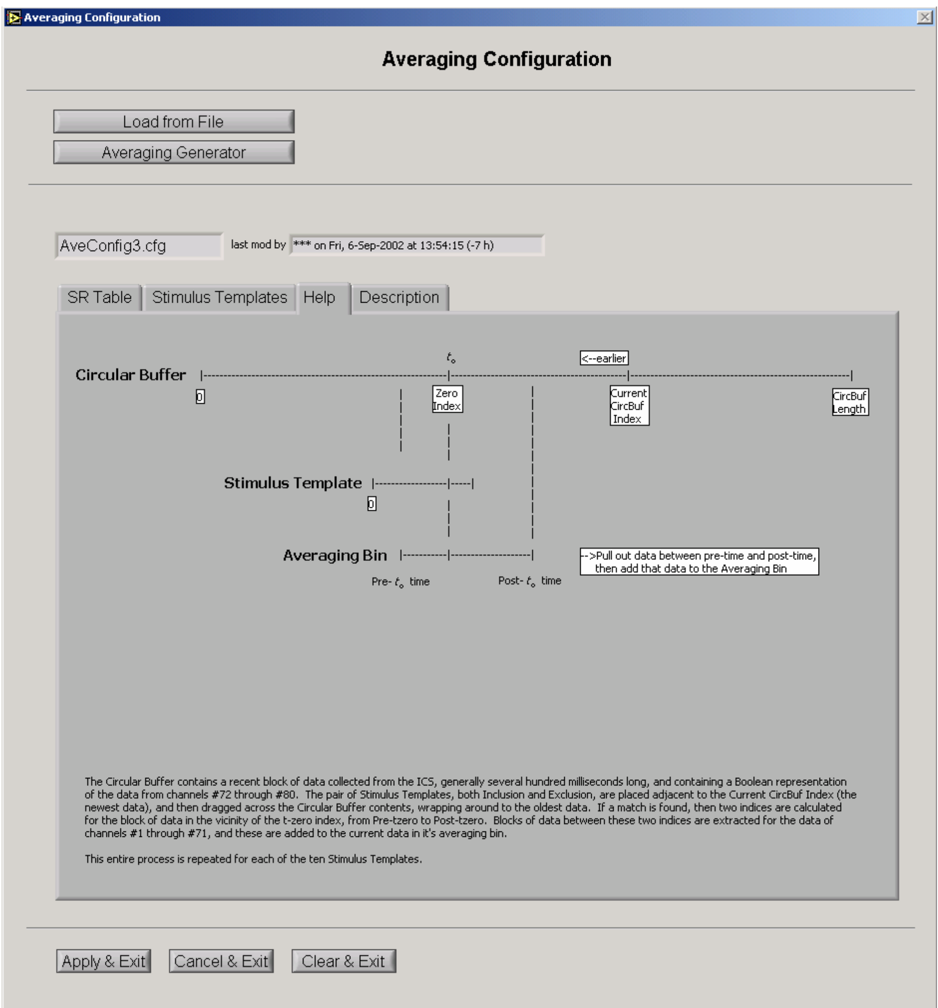

Figure 40: Averaging Configuration (Help)

Lastly, the **Description** tab shows a text description associated with the averaging configuration, as shown in **Figure 41**.

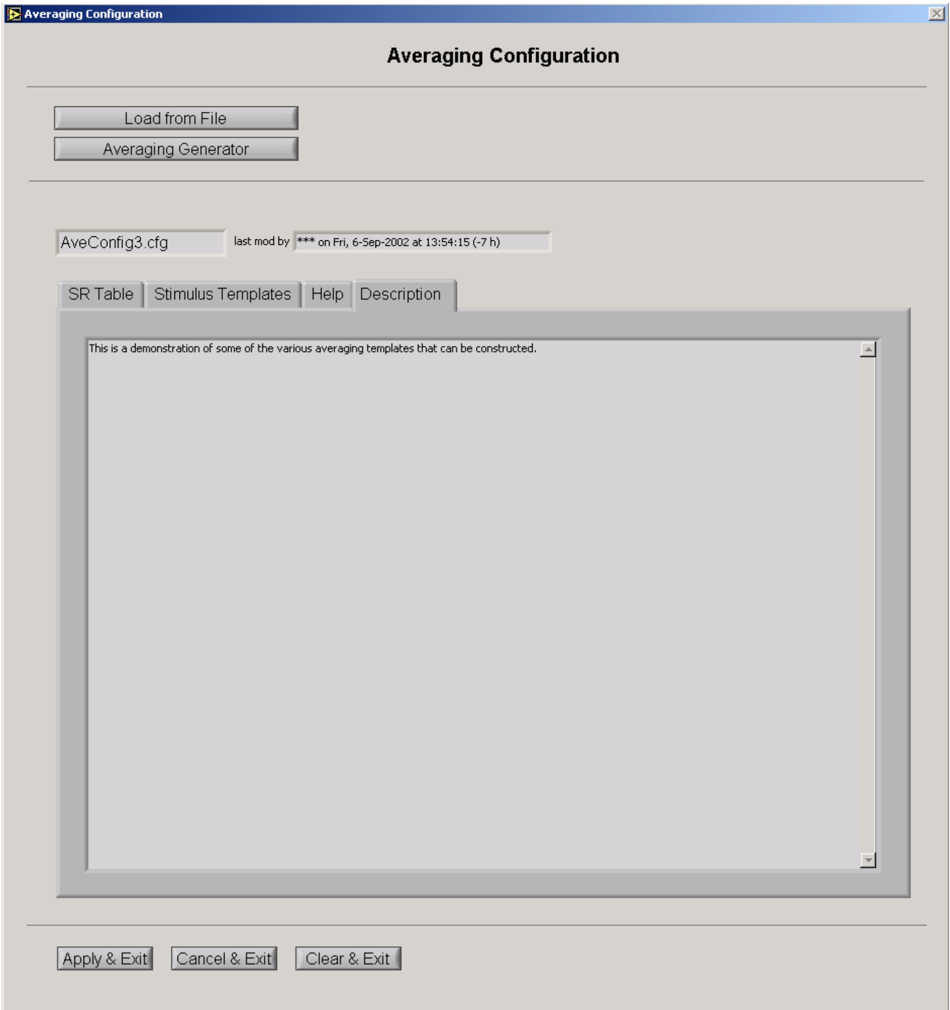

Figure 41 Averaging Configuration (Description)

To generate a new averaging file, press the *Averaging Generator* button on the Averaging Configuration panel. This brings up the Averaging Generator panel that provides generation capabilities based on that provided in Neuromag systems, as shown in **Figure 42**.

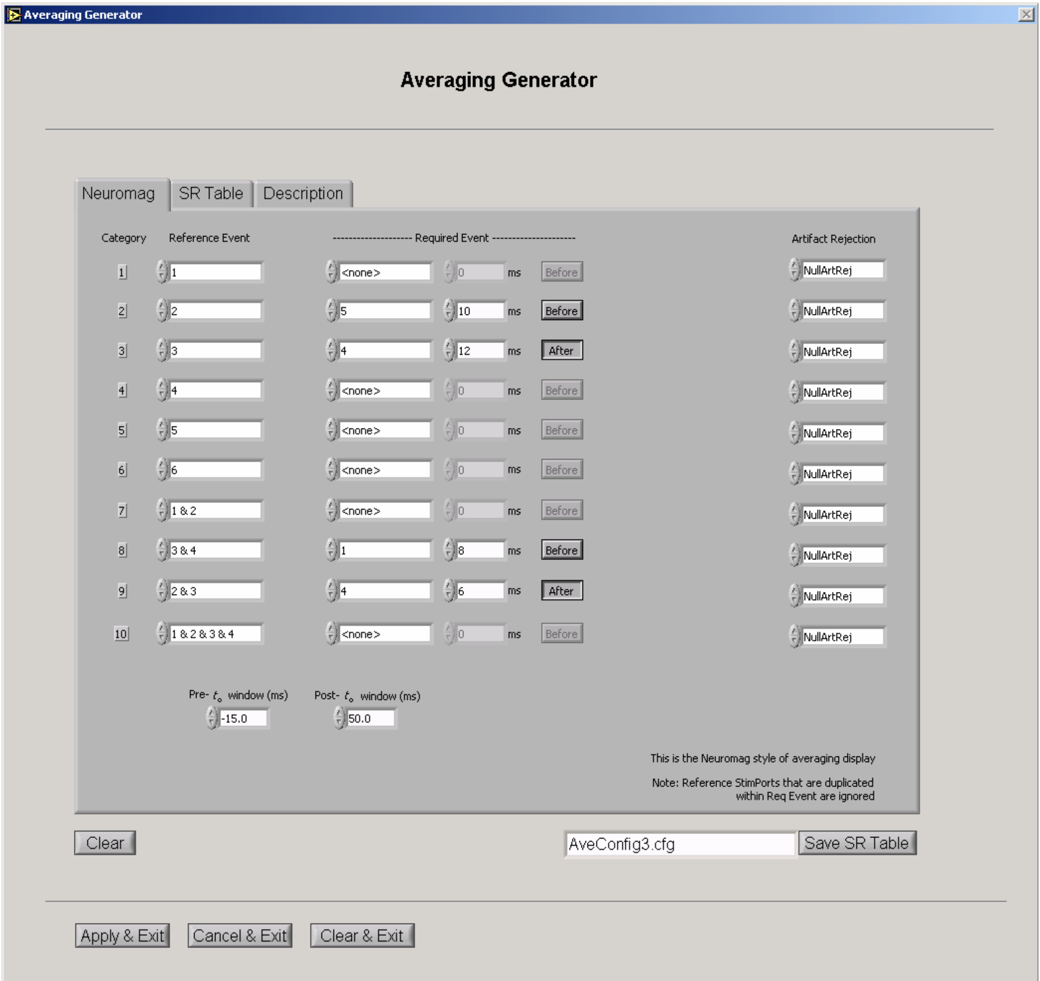

Figure 42 Averaging Generator (Neuromag)

For each of the 10 stimulus templates (categories), one may specify both Reference Events and Required Events using the displayed list-boxes; each list-box contains 18 options for StimPort combinations.

The Reference Events specifies searching for a TRUE state for the given trigger channels, and the Required Events specifies searching for an TRUE state for the given trigger signals that must occur within a time window relative to the Reference Event(s). Together, they form a stimulus template, which can be compared against real-time data to search for match occurrences. This stimulus template can be displayed as a Search Region (SR) table, as shown in **Figure 43**.

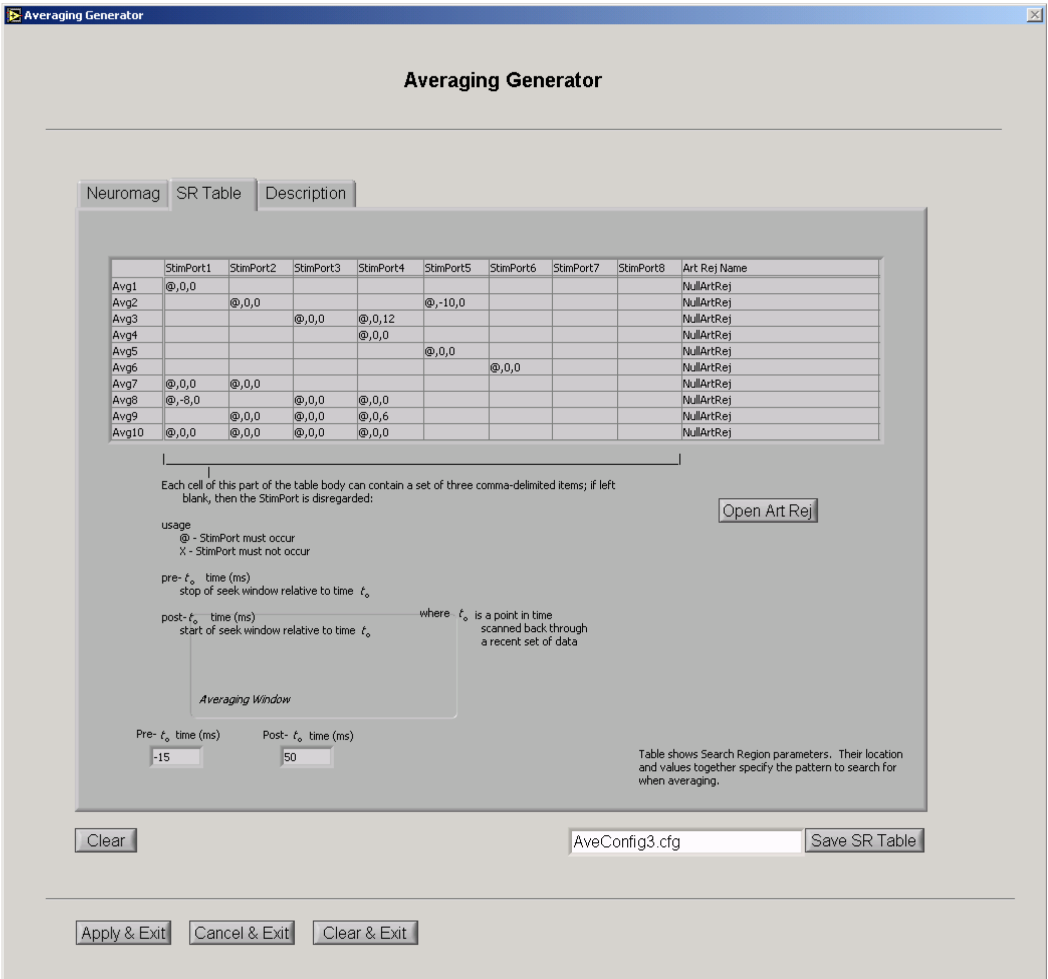

Figure 43 Averaging Generator (SR Table)

Once satisfied with the stimulus template, it may be named in the text window and saved as *.cfg using the *Save SR Table* button, in the lower right portion of the panel. After saving as a file, pressing the *Apply & Exit* button closes the Averaging Generator panel, and delivers the table to the Averaging Configuration panel.

Other tabs that are useful to the user are described below:

The **Description** tab shows a text description to be associated with the averaging configuration, as shown in **Figure 44**.

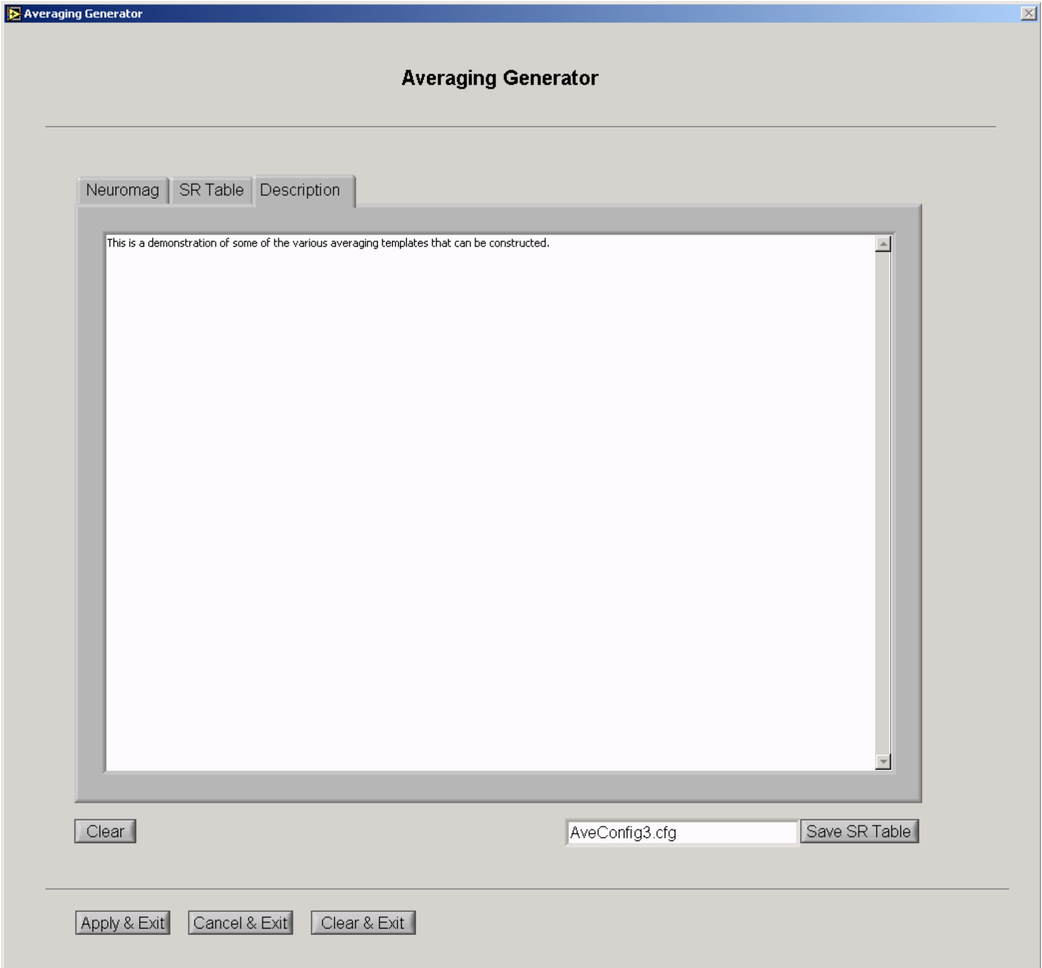

Figure 44 Averaging Generator (Description)

5.1.3 – Averaged Data tabset >> Main >> Save

The saving options allow the user to save the Averaging Display (discussed below) as a screen-dump AvgData.jpg file, and to save the averaged data as an ASCII text AvgData.txt file.

These files are located under a ~/ExperimentData/Project/Subject/Date/*_AvgImage and /*_Avg directory tree, where the ~ root directory is specified by the user in MainConfig.ini (or other user-selected *.ini file).

5.2.0 – Averaged Data tabset >> Artefact Rejection

This is disabled and is not available to the customer.

5.3.0 – Averaged Data tabset >> Filters

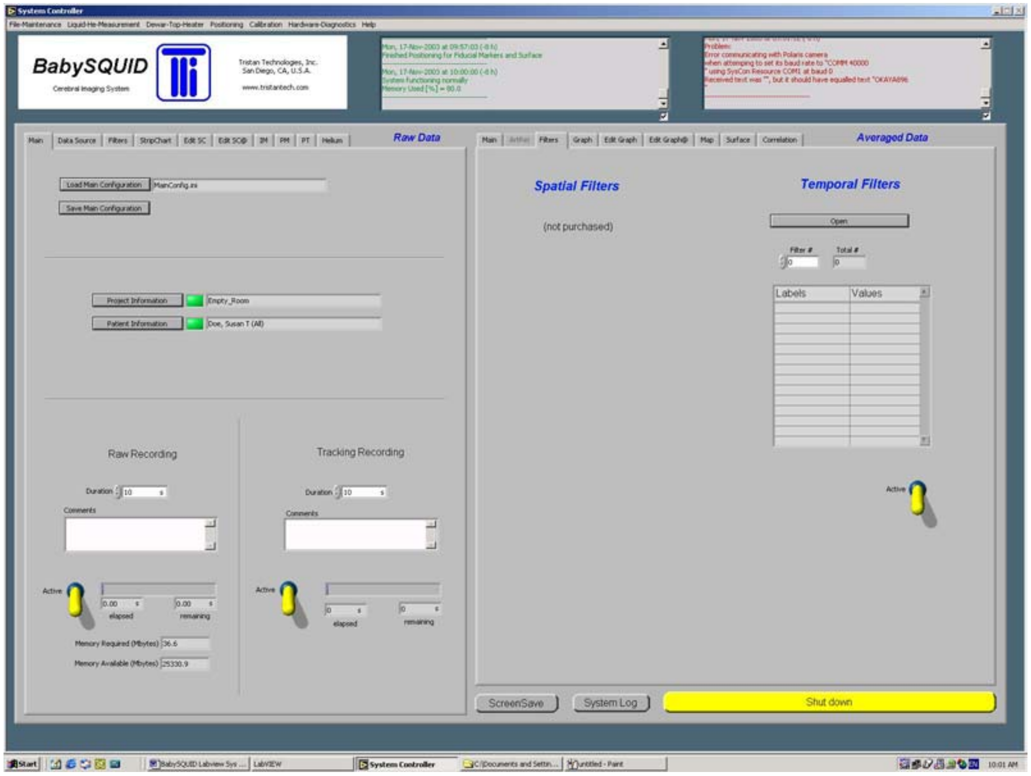

Figure 45: Averaged Data >> Filtering

This functions identically to the temporal filtering for the raw data stream. For instructions, refer to that section.

5.4.0 – Averaged Data tabset >> Graph

This contains the Averaging Graph, as shown in **Figure 46**.

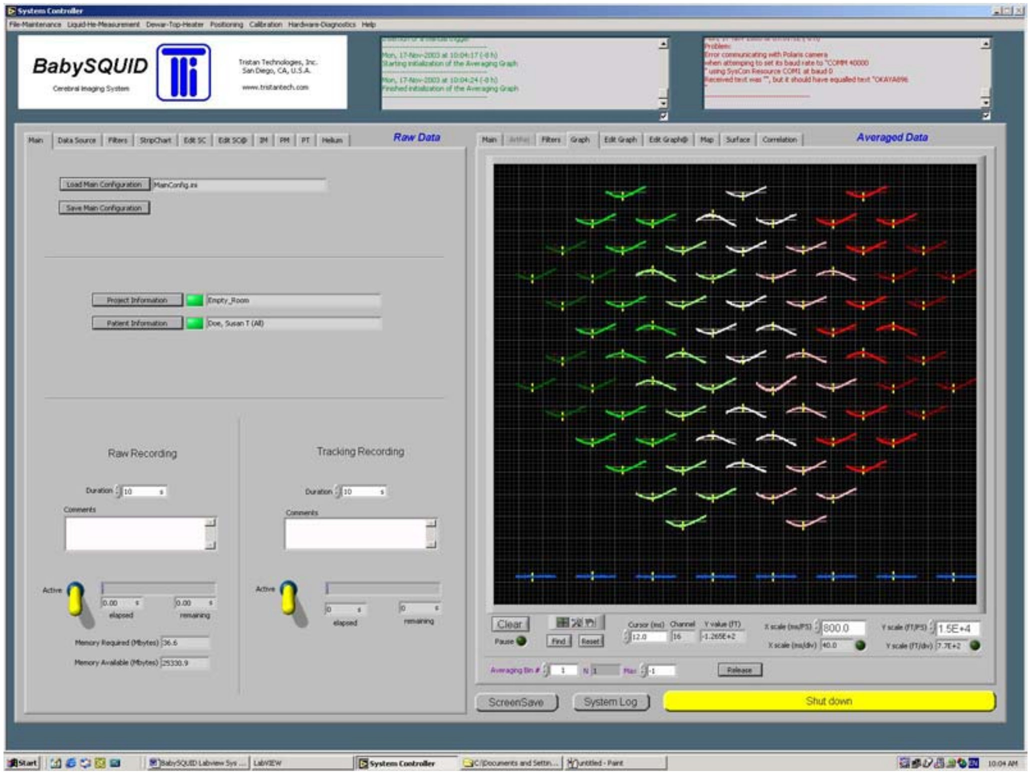

Figure 46: Averaged Data >> Graph

The graph area of this display can contain up to 120 *Graph Objects*. Each of these *Graph Objects* can contain data as determined by a formula (see below), and can be positioned, colored, and labeled by the user (see below).

The position of the movable cursor is controlled by selecting the cursor option in the Graph Palette, then grabbing any movable cursor and dragging it. Alternatively, the cursor option in the Graph Palette can be de-selected, and the cursor incremented with the digital control. A fixed “zero-mark” indicates the position of t-zero.

The X and Y scales are controlled at the lower right. The controls are for Full Scale values across the entire display, and the indicators are for scaling versus the major grid divisions. These are separated so that the grid can be automatically adjusted during zooming (see below). To the right of the Y-axis indicator is the autoscale control button.

The zoom/pan control allows the user to zoom in or out, and pan the display. Press the “Reset” button to return to the original display. Press the “Find” button to force all data to be within the boundaries of the display.

The averaging index progress is shown in purple at the lower left. The index shows the current index for the selected averaging bin. The max index stops averaging for all averaging bins when the displayed index is reached; setting to -1 allows unimpeded averaging.

5.5.0 – Averaged Data tabset >> Edit Graph

The **Edit Graph** tab shows general controls for the graph shown on the **Graph** tab, as shown in **Figure 47**.

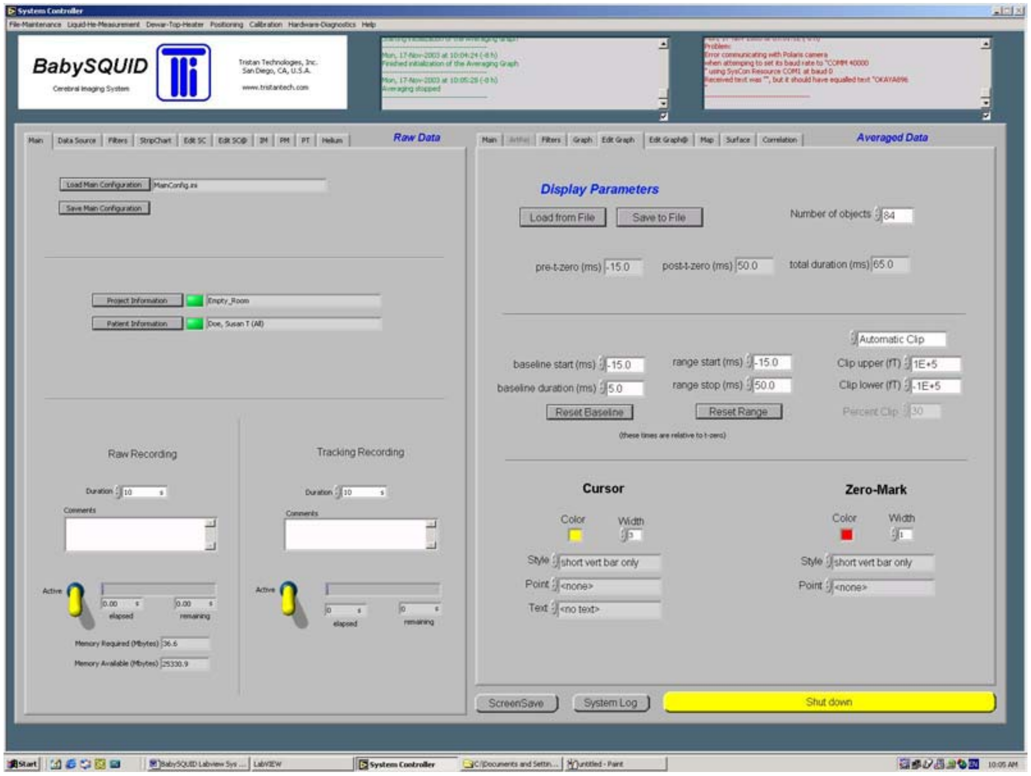

Figure 47: Averaged Date >> Edit Graph

Parameters from this tab, and also the **Edit Graph@** tab (see below), can be saved or recalled as files.

The baseline controls are for removing DC offset in the averaged data. Note that the "Baseline Start" is relative to the start of the averaging bin, not t-zero.

The range controls are for examining a particular region of the averaged data. They specify the time-span of data to be used in the **Graph** tab, so that the X-axis can be expanded with out overlapping the traces.

The clipping controls are for clipping excessive signals, so that they won't overlay on other graphs.

The properties of the movable and fixed cursors for the graph shown on the **Graph** tab can also be controlled. Note that cursor text can be controlled to display various useful information.

5.6.0 – Averaged Data tabset >> Edit Graph@

The **Edit Graph@** tab shows specific controls for the graph shown on the **Graph** tab, as shown in **Figure 48**.

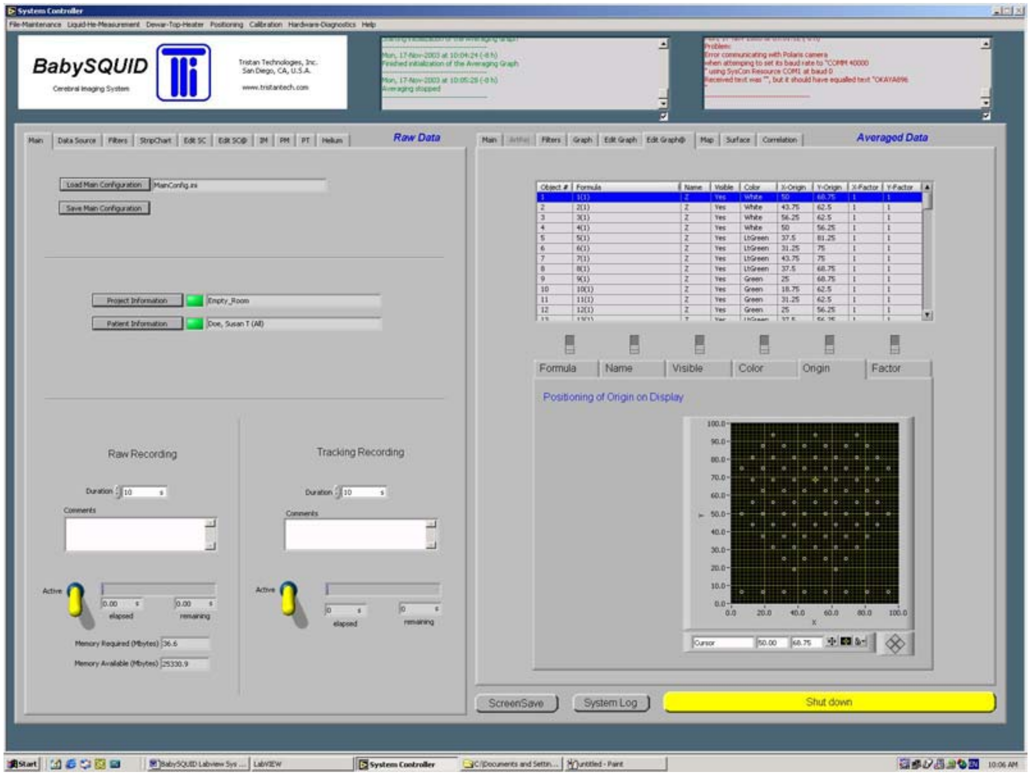

Figure 48: Averaged Data >> Edit Graph@

Within this tab are a Properties table and lower tabs for **Formula**, **Name**, **Visible**, **Color**, **Origin**, and **Factor**. The user can highlight a line in the upper table, and its properties are displayed in the lower tabs.

If the apply button is On, then the reverse is true: the tab contents control the table contents (for the highlighted table lines only). This mode is used by the user to edit the graph properties. The most complex of these is the **Origin** tab, as shown in **Figure 48**.

For example, the user can highlight a particular line in the table, press the "Apply" button, and then drag the point on the graph to a new location.

As another example, the user can go to the **Color** tab, highlight several lines in the table using the <Shift> key, press the "Apply" button, and change the color for a group of graphs.

5.7.0 – Averaged Data tabset >> Map

The **Map** tab shows the movable cursor Y values as a color scale, as shown in **Figure 49**.

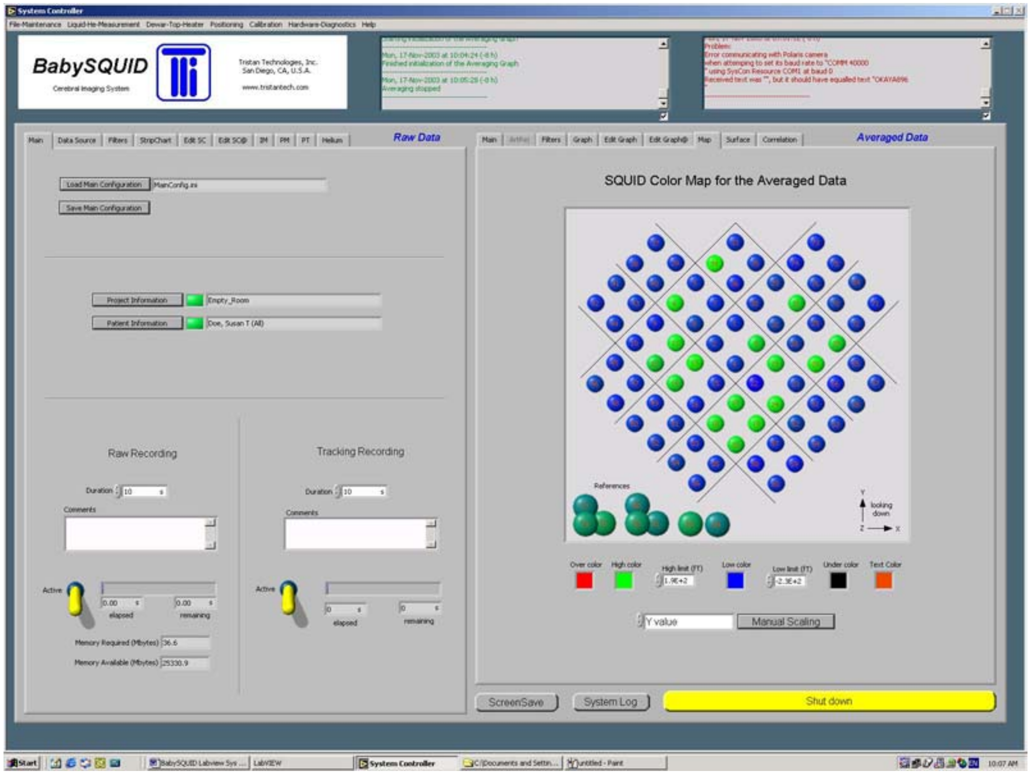

Figure 49: Averaged Data >> Map

5.8.0 – Averaged Data tabset >> Surface

The averaged data can be represented as a surface, as shown in **Figure 50**. This is a display of a specific time point (of the averaged data time series). The color of the spectral surface represents Z-axis data, and the blue dots indicate (flattened) locations of SQUID coils along the X and Y axes. The single red dot is the user-selected high-lighted coil.

The 3D plot can be adjusted by the following operations:
<shift> + Lmouse == pan
<ctrl> + Lmouse == rotate
<alt> + Lmouse == zoom

The user can repetitively scan the time axis of the averaged data, from earlier to later. If this is switched on during a nerve signal propagation study, the user would see the propagating signal during each scan pass. As averages accumulated, this moving signal would become more distinct from the background noise.

Once a sufficient number of averages has accumulated, the user can save the set of scan images, to generate a movie AVI file than shows signal propagation.

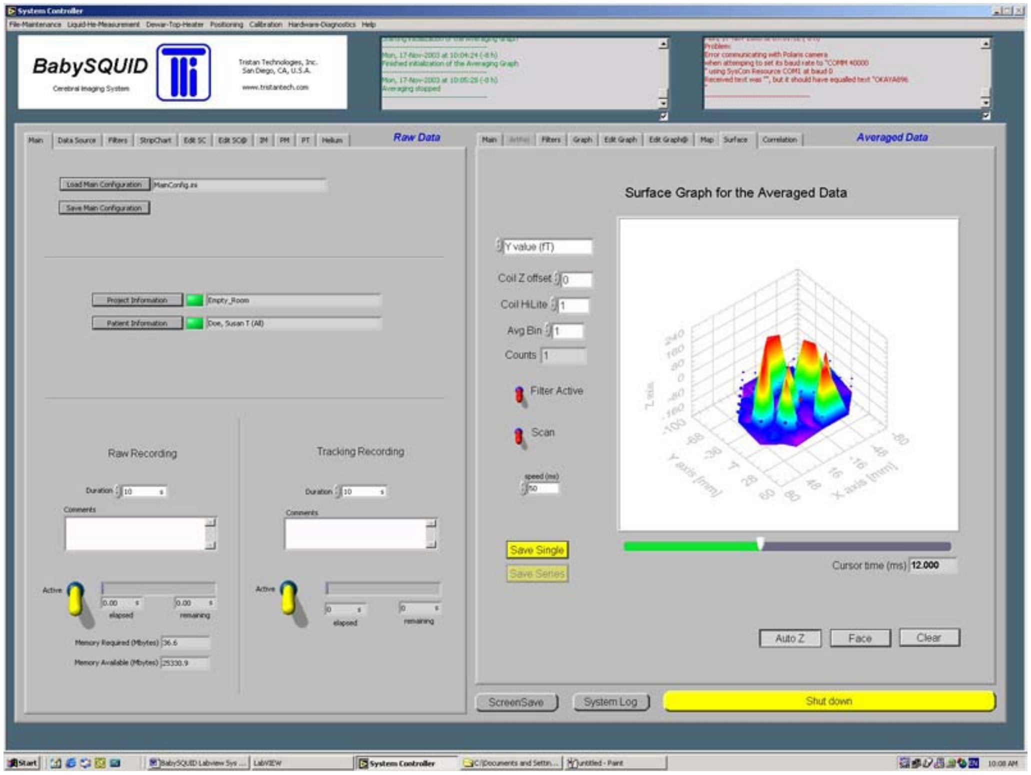

Figure 50: Averaged Data >> Surface

5.9.0 – Averaged Data tabset >> Correlation

The **Correlation** tab shows the correlation between 2 averaging bins, as shown in **Figure 51**.

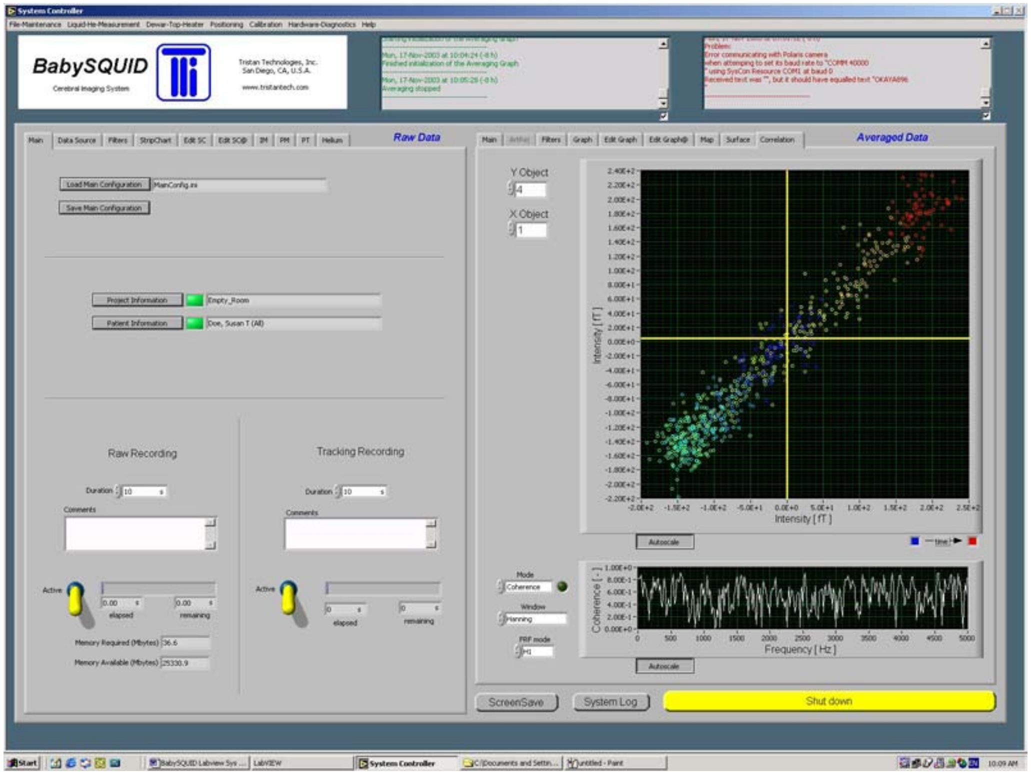

Figure 51: Averaged Data >> Correlation

With no signal, channels should have only independent noise, and so the correlation should be a simple shot-gun scatter pattern. If there is a pattern, then perhaps a spatial filter would be useful.

The lower graph shows frequency versus either magnitude, phase, or coherence.

6.0.0 – Shut down

After completing a data acquisition, the user can either continue with further work, leave the system idling, or shut down. To shut down, the user presses the *Shut down* button on the bottom left of the System Controller panel.

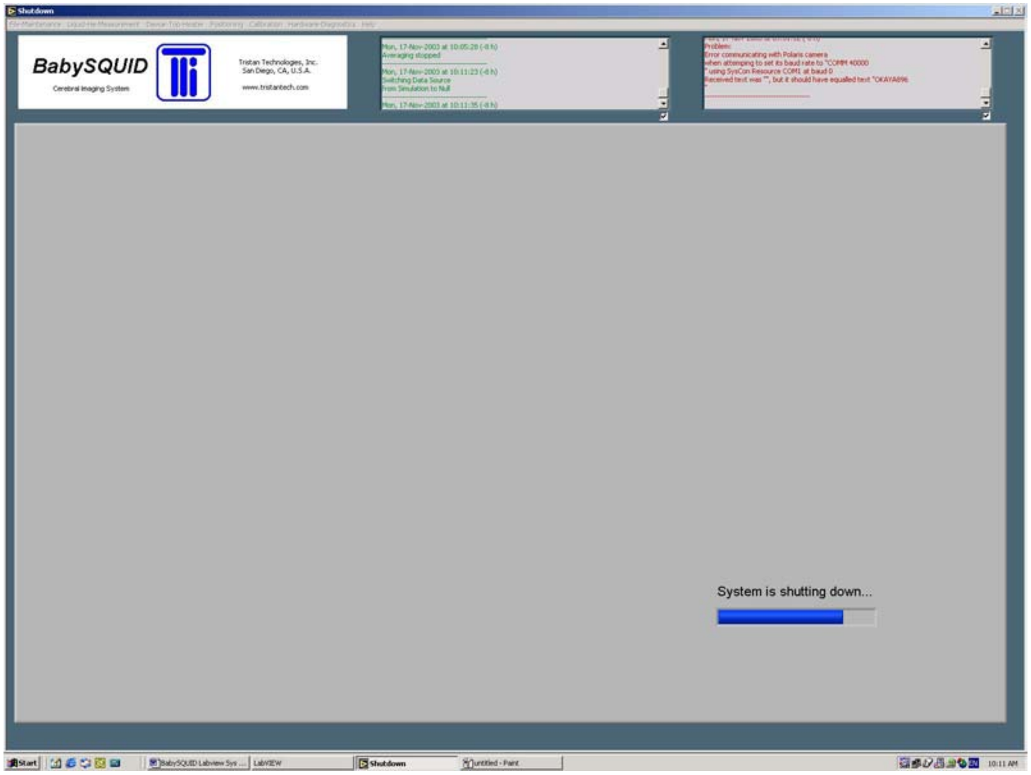

Figure 52: Shutdown

7.0.0 – System Controller menu bar

Five selections leading to useful tools and information are contained in the menu bar of the System Controller panel:

File-Maintenance

Liquid-He-Measurement

Positioning

Calibration

Hardware-Diagnostics

Help

7.1.0 – File-Maintenance

This menu item has the following children:

Extract Quiescent HeadTool Tracking Epochs examines a Tracking.bin file, and yields a tabulation of quiescent tracking epochs (QTE's) during which the subject's head did not move significantly. The user can adjust the sensitivity setting of the epoch detection.

Generate BESA Files uses the QTE tabulation with it's RawData.bin file to generate a set of BESA-formatted files. Each set consists of MUL, PMG, and SFP files, incrementally numbered. Additionally, there is a Header.txt file that specifies the source files used to generate them.

Generate EMSE Files uses the QTE tabulation with it's RawData.bin file to generate a set of EMSE-formatted files. Each set consists of DAT, ELP, and HSP files, incrementally numbered. Additionally, there is a Header.txt file that specifies the source files used to generate them.

Convert Raw BIN to TXT is available for any specialty applications that require maximum portability of the raw data.

Convert Pol BIN to TXT is available for any specialty applications that require maximum portability of the tracking data.

Clear Positioning Data allows a user to search for any files associated with the positioning system (either mapping or tracking), and delete them. This helps keep the database uncluttered with known faulty data.

Clear Temporary Folder is to be used to clear out the contents of the C:\BabySQUID\Temporary folder, as shown in **Figure 53**.

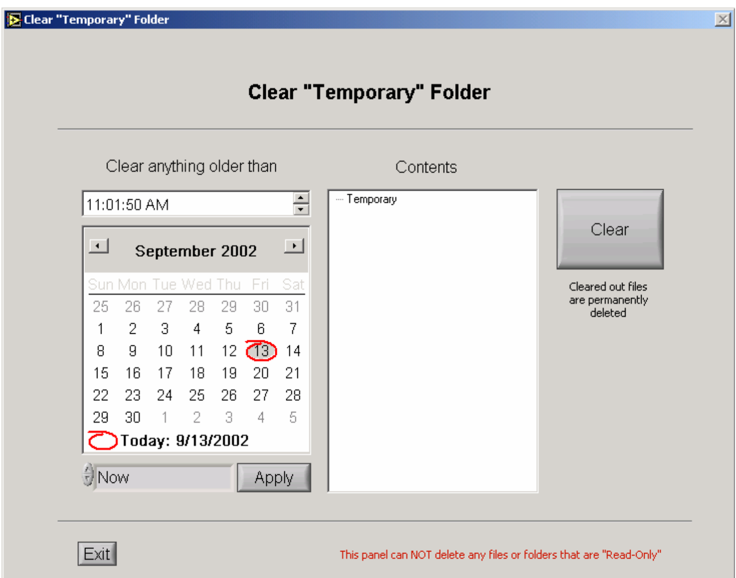

Figure 53: Clear Temporary folder

During normal system operation, files accumulate in this directory, to await final disposal by the user. Periodically, it is recommended that the user empty this directory.

7.2.0 – Liquid-He-Measurement

During regular system operation, the He level is measured automatically every hour, unless an experiment is in progress. These measurements are appended to a file, and this file is trimmed to contain only the measurements for the past 3 months. This file is the Current He Level Record.

When the cursor is placed on the Liquid-He-Measurement selection at the upper left portion of the System Controller panel, followed by a click of the left button on the mouse, the Liquid He Measurement panel will appear, as shown in **Figure 55**.

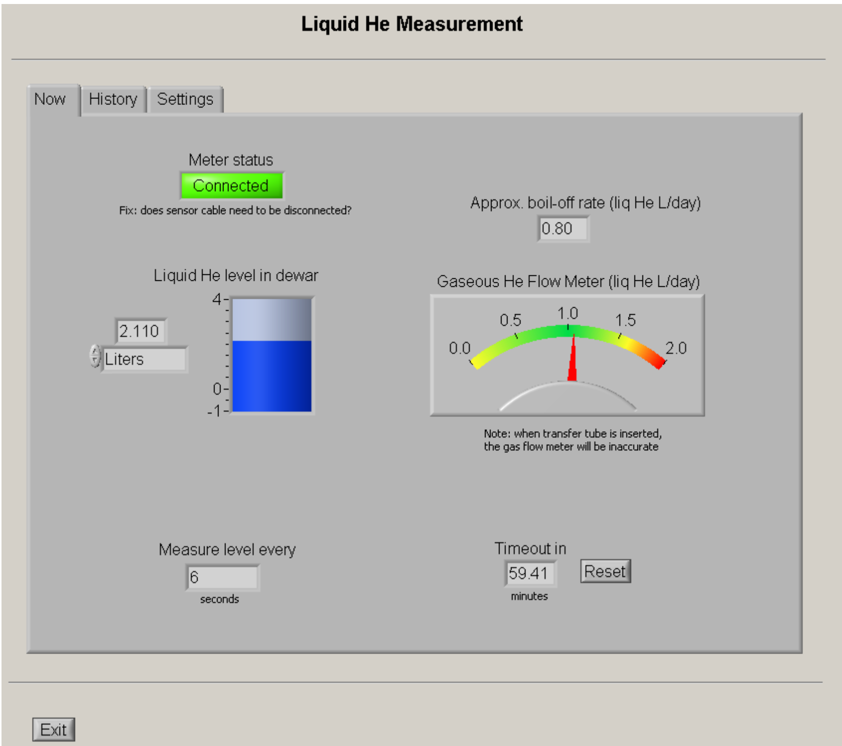

Figure 54 Liquid He Measurement (Now)

Using the **Now** tab, this panel indicates the liquid helium level in the sensor, regularly updated at a specified time interval (default is every 6 seconds). These measurements are also appended to the Current He Level Record. This panel will be used to occasionally check the helium level, and also to monitor the level during liquid helium transfers. Press the Exit button in the lower left portion of the panel to close the panel.

In the upper left portion of the **Now** tab sheet is an indicator pad indicating the status of the helium level meter; this "Connected" pad must be green, indicating that the level meter is attached and functioning in order for helium level measurements to be meaningful. Below the indicator pad is a visual display of the helium level in the Dewar and a window indicating a numerical value for the helium level. Using the pull-down listbox, the units for the helium level can be varied: Liters, Days Remaining, and cm. The Dewar has a total liquid helium reservoir volume of x liters; the vertical height of the helium reservoir sensor is 20 cm. The Days Remaining value depends on the helium level and the approximate boil-off rate specified in the window in the upper right of this tab sheet. In the lower left is a window indicating the frequency of helium level updates; the helium level meter is not left continually active since this would result in an unnecessarily high helium boil-off rate caused by the helium level measurement electronics. To the right of the update window is a window labeled "Timeout in"; this window indicates the time remaining until the helium level meter will be deactivated, and no longer perform level updates — this time remaining can be reset to the maximum value using the Reset button. In the upper right of the sheet is a window indicating the “Approx. boil-off rate (liq He L/day)”; typically, this value will be set by Tristan technicians and should not need to be reset. This approximate helium consumption rate is used when measuring the liquid helium level in units of days remaining before the level reaches zero; this value is also used for the “Approx. Liquid He Days Remaining” meter on the System Controller panel.

There are three tab sheets on this panel. Typically, one will only need the **Now** tab. The **History** tab is useful to observe variations in helium level over time, as shown in **Figure 56**.

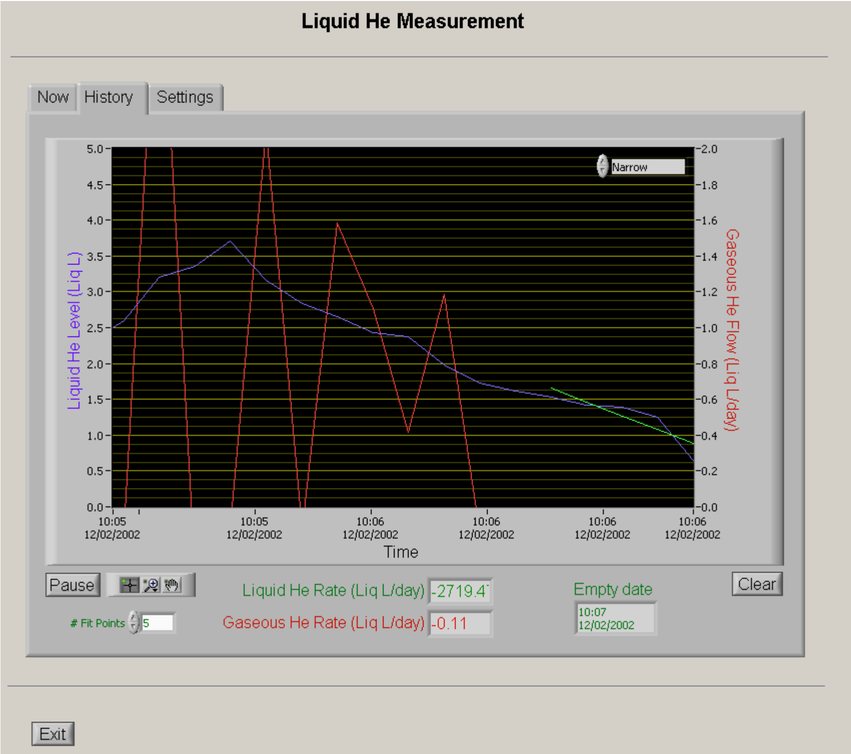

Figure 55 Liquid He Measurement (History)

It shows the contents of the Current He Level Record, with a best-fit slope line for the most recent 5 measurements. This slope is used to calculate the rate of He boil-off, and Dewar-empty date. It also shows the boil-off rate as calculated from gaseous He flow. The **Settings** tab is provided to show the various values related to helium consumption, as shown in **Figure 57**.

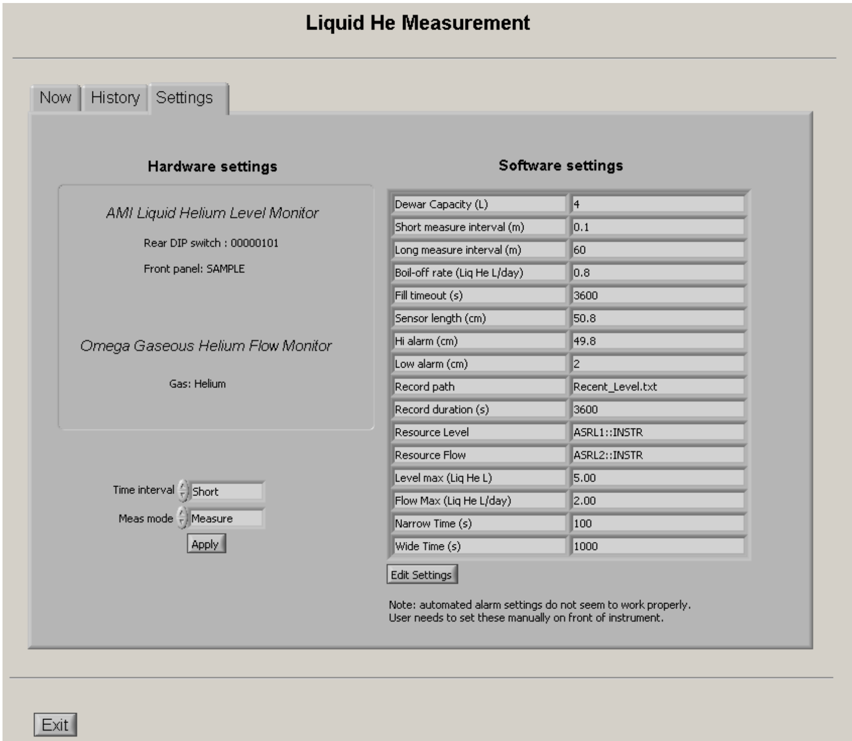

Figure 56 Liquid He Measurement (Settings)

These settings are controlled by the C:\DoCoMo\Main_Config\Constants.txt file; it is unlikely the user will ever need to change these.

7.3.0 – Positioning

This menu item provides access to the *Main GUI* and *ToolViewer*.

Main GUI is a general interface for accessing all aspects of the positioning system.

ToolViewer is a utility provided by Northern Digital Corp., for accessing direct control over the Polaris camera.

7.4.0 – Calibration

This System Controller menu item provides access to *Coil Position* and *Coil Scaling*.

Coil Position is for measuring precise locations of SQUID coils using a Locator Loop, and is generally used after a major operation such as removing the SQUIDs from the Dewar and replacing them. See the Coil Position manual for detailed instructions.

Coil Scaling is for measuring precise Tesla/volt sensitivities of the SQUID coils using a solenoid coil, and is generally used after a major operation such as removing the SQUIDs from the Dewar and replacing them. See the Coil Scaling manual for detailed instructions.

7.5.0 – Hardware-Diagnostics

This System Controller menu item provides access to *Scope, Correlation, Stimulus Test, View FLL Mapping, Serial Loopback Test, DIO Test*, *Ethernet ping*, *Network communications*, and *MAX*.

Scope is for viewing the data put out from the FLLs. Data can be viewed as an FFT to help diagnose noise problems.

Correlation is for viewing signal correlation between two channels. This can be useful in diagnosing cross-talk between channels.

Stimulus Test is for testing the stimulus electronics, as shown in **Figure 58**.

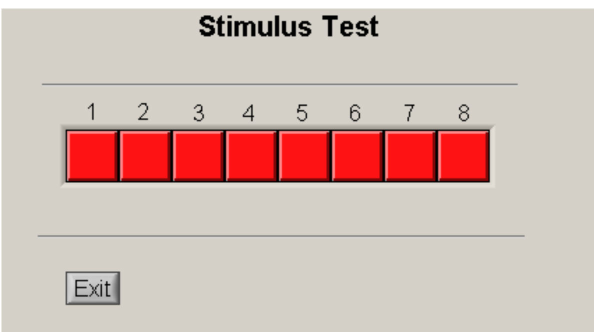

Figure 57 Stimulus Test

The panel contains 8 push buttons that allow pulses to be sent to the various stimulus output ports. This allows verification of the hardware setup to stimulate the patient.

(Note that this feature is not implemented in this release.)

View FLL Mapping is for showing the connections between SQUIDs, FLLs, and Channels, as shown in **Figure 59**.

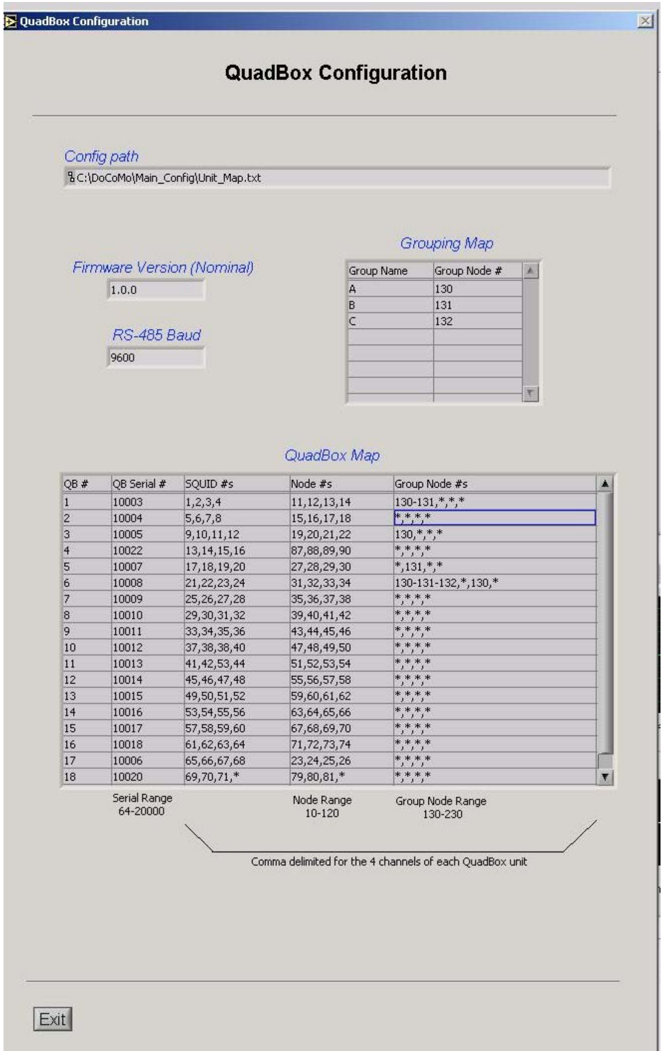

Figure 58 View FLL Mapping

Each SQUID Control unit handles 4 SQUID channels. This panel identifies which SQUID channels are connected to each SQUID Control unit. This information comes from C:\DoCoMo\Main_Config\Unit_Map.txt.

Serial Port Loopback Test is for testing the serial port connections using specially wired connectors, as shown in **Figure 60**.

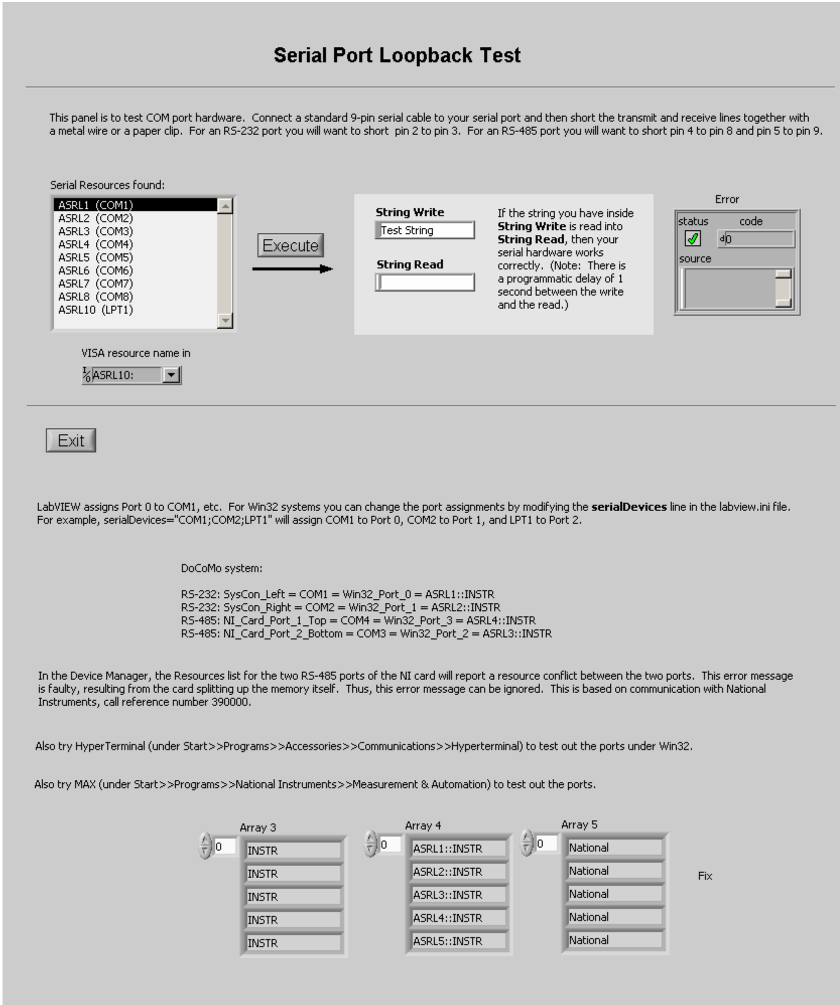

Figure 59 Serial Port Loopback Test

DIO Test is for manually switching on and off the various relays of the system, as shown in **Figure 61**.

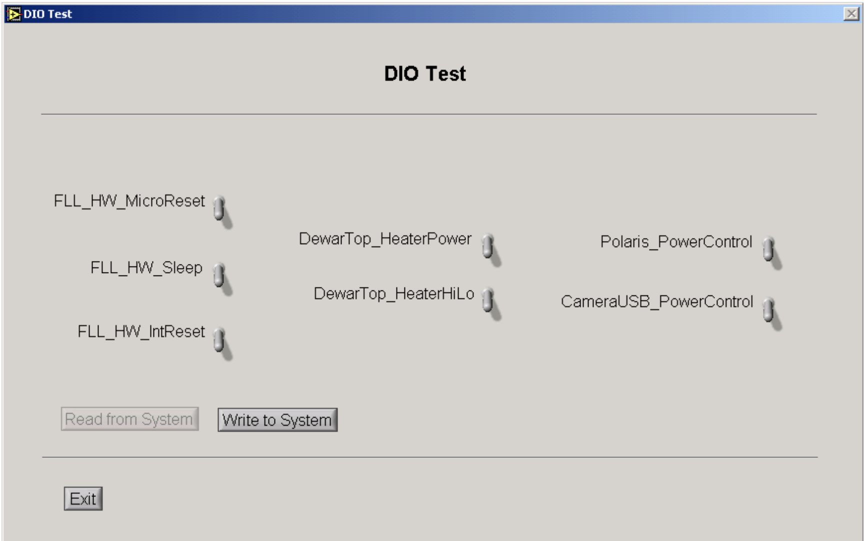

Figure 60: DIO Test

Settings are only valid while the System Controller software is running.

Ethernet ping

Network communications

MAX

7.6.0 – Help

This System Controller menu item provides access to *File Structure, Seek Modified Files, General File Viewer, Pop-up Help, Manuals, Tristan Website, Software Version, About LabView, Explain Error,* and *Stop.*

File Structure shows the files pertaining to the system.

Seek Modified Files allows the user to seek for any files that have been modified after a certain date and time.

General File Viewer is for viewing the contents of any file as ASCII, backslash, or Hex format.

Pop-up Help is for showing Help files for various items under the mouse cursor.

Manuals is for accessing the contents of all manual pertaining to the system.

Tristan Website is for accessing the Tristan website, if a web connection is enabled.

Software Version shows the current SysCon software version.

About LabView shows the current version of LabView.

Explain Error shows the meaning of various error codes.

Stop causes an immediate halt to the entire SysCon software package.

8.0.0 – System file organization

Software pertaining to the BabySQUID system is installed in these locations:

C:\BabySQUID

    LabView software for running SysCon system

C:\Program Files\Adobe

    Adobe Acrobat software for reading manuals

C:\Program Files\Canon

    Canon camera software

C:\Program Files\Eyetronics

    Grid image processing software

C:\Program Files\National Instruments

    LabView environment for running SysCon software

C:\Program Files\Northern Digital Inc

    Polaris binocular infrared camera software

C:\WINNT\ToolViewer.ini

    Polaris initialization file

C:\WINNT\WinPolarisSample.ini

    Polaris initialization file

8.1.0 – BabySQUID folder

The user should be most familiar with the C:\BabySQUID directory, as this is where experimental configurations and experimental data are stored.

The structure of the directory is shown below:

C:\DoCoMo\Ave_Config

*Contains a library of *.cfg files for defining the averaging configuration*

C:\DoCoMo\Calibration

GainCorr_71Squid.txt → *associates a nominal gain (1, 10, or 100x) with an actual gain*

TperV_71Squid.txt → *SQUID calibrations of Tesla per volt sensitivity*

ScaleCal1.txt → *raw calibration data to be used for calculating T per V sensitivity*

C:\DoCoMo\Channel_Sets

SetName → *folder name is group of channel sets*

OOR_Run.txt → *list of SQUID channels Out Of Range in FLL Run mode*

OOR_Tune.txt → *list of SQUID channels Out Of Range in FLL Tune mode*

SetA.txt → *list of SQUID channels defined by user*

SetB.txt → *list of SQUID channels defined by user*

SetC.txt → *list of SQUID channels defined by user*

C:\DoCoMo\Current_Experiment

Contains copies of configuration files in recent use, a copy of the current System_Log file, and contains any decimated averaged data. A copy of this entire folder forms a record of all information pertaining to an experiment (except for the raw data itself), and is sent to the HP for archiving. See below for more information.

C:\DoCoMo\DAQ_Config

*Contains a library of *.cfg files for defining the FLL configuration*

C:\DoCoMo\Filter_Config

*Contains a library of *.cfg files for defining the filter configuration*

C:\DoCoMo\He_Level_Record

Recent_Level.txt → *history of liquid He level over the past X months*

C:\DoCoMo\ICS_Config

*Contains a library of *.cfg files for defining the ICS configuration*

C:\DoCoMo\Main_Config

Constants.txt → *various default settings that pertain to the overall running of the system*

Last_Main.cfg → *most recent configuration files loaded*

SQUID_Map.txt → *map of which SQUIDs are connected to which data channels*

Unit_Map.txt → *map of which FLL nodes are connected to which data channels*

C:\DoCoMo\Manuals

*Contains various *.pdf files that are available to the user*

C:\DoCoMo\Patient_Database

PatientA → *folder name is the patient ID*

Notes.txt → *miscellaneous text provided by the user, pertaining to this patient*

StandardFields.txt → *name, DOB, height, weight, etc. of this patient*

SysInfo.txt → *record of edits to this patient's database*

UserFields.txt → *empty, un-named fields accessible to the user*

etc.

C:\DoCoMo\Positioning_Database

BedTool.rom → *Polaris rom file for the BedTool*

CoilCalib.pol → *SQUID coil locations as determined by the Locator Loop*

CoilCalib1.mtx → *matrix transformation of Dewar coils relative to DewarTool1*

CoilCalib2.mtx → *matrix transformation of Dewar coils relative to DewarTool2*

Dewar_Map_71.dwr → *mechanical locations of SQUID coils from engnrg drawings*

DewarTool1.rom → *Polaris rom file for the DewarTool1*

DewarTool2.rom → *Polaris rom file for the DewarTool2*

GridCal.ssc → *Eyetronics calibration file generated from imaging the Dotted Roof*

LocatorLoop.rom → *Polaris rom file for the Locator Loop*

StylusTool.rom → *Polaris rom file for the Stylus*

ToolSettings.txt → *list of Tool rom files uploaded to the Polaris camera*

C:\DoCoMo\Project_Database

ProjectA → *folder name is the project name*

Investigators.txt → *list of investigators involved in this project*

Notes.txt → *miscellaneous text provided by the user, pertaining to this project*

Purpose.txt → *purpose of this project*

SysInfo.txt → *record of edits to this project's database*

etc.

C:\DoCoMo\Stimulus_Config

*Contains a library of *.cfg files for defining the stimulus configuration*

C:\DoCoMo\System_Log

MonYear → *logs are divided by month for organizational purposes*

DDMMYYYY_HHh_MMm_SSs_p#z.log → *log for each SysCon sw start-up*

Summary.txt → *log of all SysCon software start-ups*

C:\DoCoMo\Temporary

Contains miscellaneous deleted items awaiting permanent disposal

C:\DoCoMo\Trial_Definitions

*Contains a library of *.cfg files for defining Trial Definitions (not available to DoCoMo)*

8.2.0 – Current_Experiment folder

The contents of the C:\DoCoMo\Current_Experiment folder are shown below. There is also a separate manual (*Current_Experiment Example Files*) that gives examples for each of the files that it contains. This folder will continue to accumulate files and folders until the user manually clears it out by using the *Clear-Cur-Experiment* menu item of the System Controller menu bar. The purpose of this folder is to serve as a record of all configurations and data (except the raw data itself) for an experiment. A copy of it is sent to the HP for archiving, and is re-named to *_Header.

C:\DoCoMo\Current_Experiment\Ave_Config

*Contains *.cfg files defining the averaging configurations used during this experiment*

C:\DoCoMo\Current_Experiment\Ave_Data

*Contains *.dav files containing data from averaging of real-time decimated data*

*Contains *.jpg files containing screen dumps of the Averaging Display graph*

C:\DoCoMo\Current_Experiment\Calibration

GainCorr_71Squid.txt → *associates a nominal gain (1, 10, or 100x) with an actual gain*

TperV_71Squid.txt → *SQUID calibrations of Tesla per volt sensitivity*

ScaleCal1.txt → *raw calibration data to be used for calculating T per V sensitivity*

C:\DoCoMo\Current_Experiment\Channel_Sets

SetName → *folder name is group of channel sets*

OOR_Run.txt → *list of SQUID channels Out Of Range in FLL Run mode*

OOR_Tune.txt → *list of SQUID channels Out Of Range in FLL Tune mode*

SetA.txt → *list of SQUID channels defined by user*

SetB.txt → *list of SQUID channels defined by user*

SetC.txt → *list of SQUID channels defined by user*

C:\DoCoMo\Current_Experiment\DAQ_Config

*Contains *.cfg files defining the FLL configurations used during this experiment*

C:\DoCoMo\Current_Experiment\Filter_Config

*Contains *.cfg files defining the filter configurations used during this experiment*

C:\DoCoMo\Current_Experiment\He_Level_Record

Recent_Level.txt → *history of liquid He level over the past X months*

C:\DoCoMo\Current_Experiment\Main_Config

Constants.txt → *various default settings that pertain to the overall running of the system*

Last_Main.cfg → *most recent configuration files loaded*

SQUID_Map.txt → *map of which SQUIDs are connected to which data channels*

Unit_Map.txt → *map of which FLL nodes are connected to which data channels*

C:\DoCoMo\Current_Experiment\Patient_Database

PatientA → *folder name is the patient ID*

Notes.txt → *miscellaneous text provided by the user, pertaining to this patient*

StandardFields.txt → *name, DOB, height, weight, etc. of this patient*

SysInfo.txt → *record of edits to this patient's database*

UserFields.txt → *empty, un-named fields accessible to the user*

C:\DoCoMo\Current_Experiment\Positioning

BedBodypoints_Before_###.pol → *Bodypoints and BedTool locations in Pol coord frame*

BedDewar_After_###.pol → *DewarTools and BedTool locations in Pol coord frame*

BedDewar_Before_###.pol → *DewarTools and BedTool locations in Pol coord frame*

BedTool.rom → *Polaris rom file for the BedTool*

Coils_After_###.pol → *Coil and BedTool XYZs in Polaris coordinate frame*

Coils_Before_###.pol → *Coil and BedTool XYZs in Polaris coordinate frame*

Coils_Before_###.pol_normal → *Coil and BedTool normal vectors in Polaris coord frame*

Coils_Before_###.sbj → *Coil and BedTool XYZs in Subject coordinate frame*

Coils_Before_###.sbj_normal → *Coil and BedTool normal vectors in Subject coord frame*

DewarTool1.rom → *Polaris rom file for the DewarTool1*

DewarTool2.rom → *Polaris rom file for the DewarTool2*

EyeGridinPol_###.pol → *Eyetronics grid XYZs in Polaris coordinate frame*

EyeGridinSubject_###.sbj → *Eyetronics grid XYZs in Subject coordinate frame*

GridRef1.xyz → *Eyetronics grid XYZs for Body Marker #1 in Eyetronics coord frame*

GridRef2.xyz → *Eyetronics grid XYZs for Body Marker #2 in Eyetronics coord frame*

GridRef3.xyz → *Eyetronics grid XYZs for Body Marker #3 in Eyetronics coord frame*

GridRef4.xyz → *Eyetronics grid XYZs for Body Marker #4 in Eyetronics coord frame*

Image1.jpg → *Raw image file from Canon camera*

Image1.obj → *Eyetronics grid XYZs in Eyetronics coord frame*

Image1.ss3d → *Eyetronics 3D imaging file*

LocatorLoop.rom → *Polaris rom file for the Locator Loop*

StylusTool.rom → *Polaris rom file for the Stylus*

ToolSettings.txt → *list of Tool rom files uploaded to the Polaris camera*

C:\DoCoMo\Current_Experiment\Project_Database

ProjectA → *folder name is the project name*

Investigators.txt → *list of investigators involved in this project*

Notes.txt → *miscellaneous text provided by the user, pertaining to this project*

Purpose.txt → *purpose of this project*

SysInfo.txt → *record of edits to this project's database*

C:\DoCoMo\Current_Experiment\Stimulus_Config

*Contains *.cfg files defining the stimulus configurations used during this experiment*

ICS → *folder containing actual trigger files uploaded to ICS*

Readme.txt → *user text describing the triggering pattern*

Trigger1.dat → *trigger time and duration file, in microseconds*

Trigger2.dat → *trigger time and duration file, in microseconds*

Trigger3.dat → *trigger time and duration file, in microseconds*

Trigger4.dat → *trigger time and duration file, in microseconds*

Trigger5.dat → *trigger time and duration file, in microseconds*

Trigger6.dat → *trigger time and duration file, in microseconds*

Trigger7.dat → *trigger time and duration file, in microseconds*

Trigger8.dat → *trigger time and duration file, in microseconds*

C:\DoCoMo\Current_Experiment\System_Log

Current.log → *log of SysCon messages since the most SysCon software start-up*

9.0.0 – Addendum: Cursor/Zoom/Pan Control

The Cursor/Zoom/Pan control is shown below in **Figure 62**.

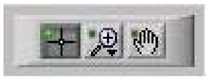

Figure 61: Cursor/Zoom/Pan control

The left palette item allows the user to grab and drag a cursor on the graph.

The center palette item allows the user to zoom in and out of a graph, using one of 6 different modes.

The right palette item allows the user to pan along a graph.