Riverside Research Institute

To: Biomed group
From: Jeff Ketterling
Date: September 12, 2003
Subject: How to use new scanning system.

This memo discusses the operation of the new automated scanning system. The focus is on how to operate the software, rather than technical aspects of the how the overall system works. For a description of how the software works, examine the block diagrams of the LabVIEW VIs. Most have notes indicating what is being done. The computer used to control the apparatus requires the account"biomed" with a password 1234.

1 Wiring Connections

The BNC cable wiring schematic for the scanning system at RRI is shown in Fig. 1(a). All of the equipment is either mounted on a relay rack or in the controlling computer. The switch box permits software selection of a PRF from either a motor or a function generator. Cables connect cards in the computer to the appropriate components in the relay rack. These include connections between a Motion Master 2000 or National Instruments motion control card and a break out box, a GPIB card and several pieces of equipment (Fig. 1(a)), and a multipurpose data acquisition card and a break out box. A trigger line and RF line also go to an Acqiris DP110 A/D card. Additional cables link the three DC motors to a driver box on the relay rack.

A reduced version system without a therapy component is shown in Fig. 1(b). This system is currently set up in Hawaii. Both systems use the same operating software except that the Hawaii system has fewer available options. The national instruments software will work with both stepper and DC motor systems.

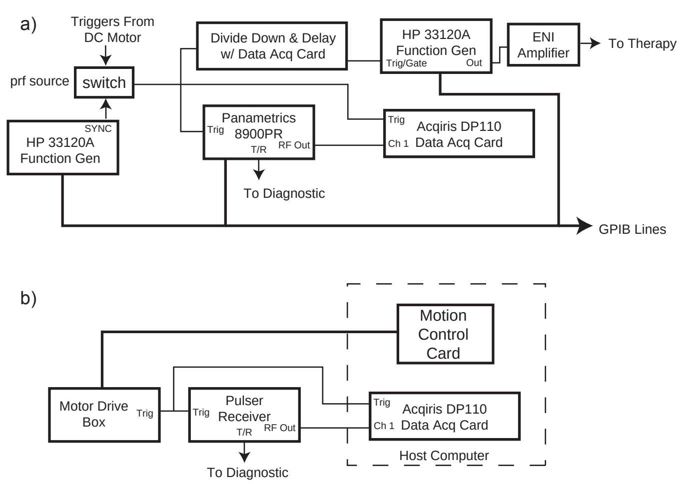


Figure 1: Wiring diagram for equipment.

The switch box provides signal connections between the 6024E and Motion Master 2000 cards (Fig 2) and is only used at RRI. The box three inputs (the function generator PRF) and two outputs (a digitizer/panametrics trigger and a therapy gate/trigger). The connections shown in

Fig 2 that refer to a pin number and wire color are for the auxiliary connector of the Motion Master 2000 interface box, the numbers toward the bottom of the figure refer to pins on the 6024E. The connection is made via a DIN cable that hangs out of the box. The motor trigger BNC is used only for NI based motion control and the DIN cable should be disconnected in this case.

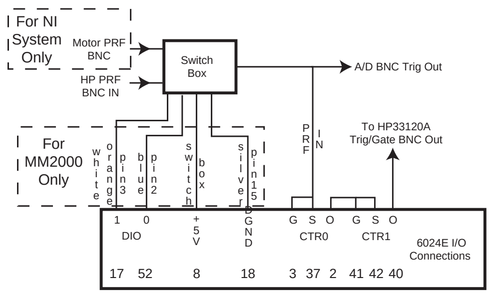
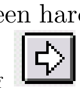


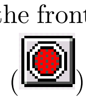
Figure 2: Wiring diagram for PRF source switching box. A pin number plus wire color refers to the Motion Master 2000 connections card. The connections are made via a 15 pin DIN cable than connects to AUX connector of the MM2000 axis break out box.The numbers at the bottom of the figure refer to pin numbers of the National Instruments 6024E card. A BNC input for the motion trigger is used for NI systems

Inside the switch box, the PRF signals from the function generator and motor first pass through TTL circuits. The circuits are a SN7405 hex inverter for the motor PRF pulse, and a SN54122 monostable multivibrator for the function generator PRF source. The SN7405 acts as a protection buffer for the Motion Master 2000 I/O line. The SN54122 reduces the PRF duty cycle from the HP33130A to avoid trigger problems with the Panametrics 5900PR (refer to 5900PR manual for more info). A two line multiplexer (SN54157) is then used to select either the function generator or the motor pulse as the PRF source used to trigger the A/D card. The selection is done via software on line 2 of the 6024E card.

2 Using the Scan System

The operation of the scan system is controlled through the vi named *mastercontrol.vi* (Fig 3). *Mastercontrol.vi* is a portal to all components of data acquisition and motion control. **Before running *mastercontrol.vi*, turn on all electrical components of the scan system (HP function generators, Panametrics, and motor power supply), except for the ENI amplifier.** The type of motion system in use should be selected and if it is not an available option, it has been hardwired into the program. The system is now ready to use and the vi is executed by pushing  in the upper left corner of the vi.

The options in the green box labeled Motion Control allow for movement of the translation stages. The pull down menu above the *Go* key selects what data acquisition mode is used. After choosing a mode, pushing *Go* activates the selected mode. Pushing *Exit* terminates execution of the program.

Occasionally, the Motion Master 2000 Board will not respond upon initialization, causing the software to hang up. When this occurs, the vis won't respond when options are selected on the front panel. If this should happen, force termination of the program by pressing the stop button (). Close all open vis except for *mastercontrol.vi* and then execute *mastercontrol.vi* again.

The operation of *mastercontrol.vi* will be discussed in terms of its subsystems. The subsystems are usually separate vis but they are not meant to be used as stand alone programs. As the overall

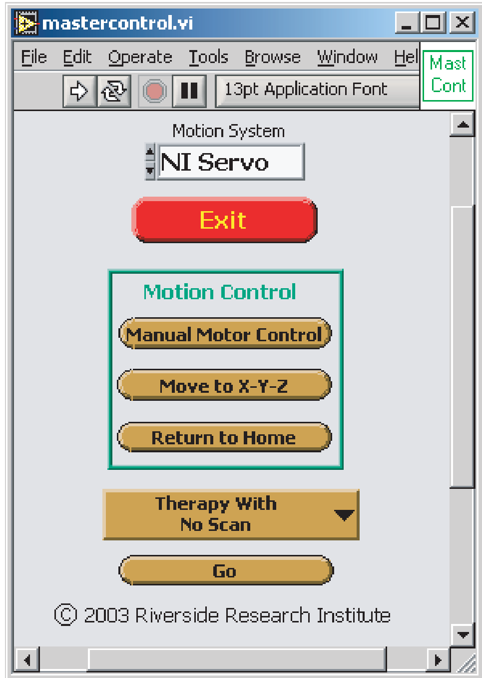


Figure 3: Image of the *mastercontrol.vi* control panel.

program is used, various other vi windows will open as options are selected. **It is important to remember that once done with these new windows, they should be closed by pushing the red *Done* button. Do not force the vi window closed or simply return to the original vi with a mouseclick.**

The remaining subsections discus the operation of the *mastercontrol.vi* and its subsystems roughly in the order that the options will be encountered.

2.1 Positioning the Transducer

The first options after executing *mastercontrol.vi* are for motion control. They are in the green box labeled Motion Control. The first two options (*manual motion control* and *move to X-Y-Z*) open new vis. The third option, *Return to Home*, returns the translation stages to the (X, Y, Z)=(0,0,0) position.

Pushing *manual motion control* opens the vi named *MM2KManCTRL.VI* (Fig. 4(a)). This vi allows for manual movement of the translation stages. Each axis has a set of controls allowing continuous or incremental movement. The current position is actively updated as motion takes place.

Continuous motion is accomplished by depressing the buttons marked *minus* or *plus*. The translation stage for that axis will move while the button is pressed. Once released, the stage will stop. If the blue circular buttons are pushed, the stage will move in 1 cm steps. To reset to the zero position, simply push the black button *Rst*. When through positioning the stages, select *Done*. *MM2KManCTRL.VI* will then close and you will return to *mastercontrol.vi*.

Pushing *move to X-Y-Z* opens another vi named *MoveToXYZ.vi* (Fig. 4(b)). This vi allows movement based on the input co-ordinates. Entering new co-ordinates moves the motor to the new position. Like before, the position can be reset to zero at any time and when through with the program, pressing *Done* returns to *mastercontrol.vi*.

Note that the maximum translation for the X and Y stages is 10 cm and for the Z stage 5 cm.

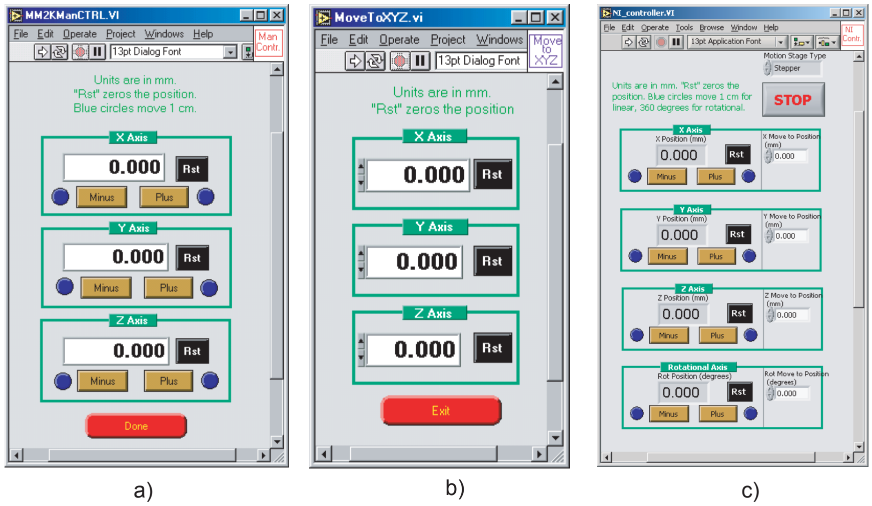


Figure 4: (a) Control panel for *MM2KManCTRL.VI*. Depressing *minus* or *plus* moves the translation stages until the button is released. The circular buttons move the stages in 1 cm increments. *RST* makes the current position the zero position. (b) Control panel for *MoveToXYZ.vi*. Entering an absolute position into the position indicator moves the motor to that position. Pushing *Rst* resets the position indicator to zero. (c) New software that has both functions combined.

If the motor moves too far, it will activate a stop switch and the motor will wait until it is moved back to a valid position. **Therefore, it is important to make sure enough space is available before taking any B scans.**

2.2 Scan Modes

Once the translation stages are positioned, a scan mode can be entered. The scan modes are entered by selecting an option from the pull down menu above the *Go* button (Fig. 5). Except for the first scan mode option, all the modes take scan line data and use the same vi. Each mode will be discussed separately since the options change slightly for each mode.

2.2.1 Therapy With No Scan

This mode allows the therapy transducer to be fired for a selected number of seconds. No scan lines are taken in this mode. When the mode is selected, a new vi opens up *Therapy.vi* (Fig. 6). This vi permits a selection of the therapy frequency, amplitude, and how long the therapy fires. Once these values are chosen, selecting *Start Therapy* activates the therapy transducer. **To stop the therapy burst in the middle of operation, you can either press** *Emergency Stop* **or the Esc key on the keyboard.** When finished with this mode, pushing *Done* returns to *mastercontrol.vi*.

2.2.2 Therapy With Scan

The Therapy With Scan mode allows for a pre and post look M-Scan when the therapy transducer is fired. When this mode is selected, *AcqCont.vi* opens with options for this particular mode (Fig. 7). *AcqCont.vi* will be used by all the remaining modes with slightly different input parameters for each mode. Therefore, the discussion will be a bit more detailed in this section to introduce the common features used in all the modes. The general layout is for the the control features to be on the left and the display features on the right. The discussion will follow a counter clockwise route for how to operate the vi.

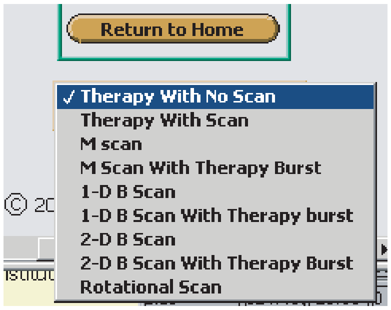


Figure 5: Scan menu in *mastercontrol.vi*. After selecting a scan mode, pressing *Go* activates that modes control vi.

Figure 6: Control panel for *therapy.vi*. After selecting parameters in the green box, pushing *Start Therapy* fires the therapy transducer for the selected amount of time. Pushing *Emergency Stop* or Esc will stop the therapy signal.

The *prf (kHz)* selects the prf from the HP33120A function generator (GPIB 11). Next to it, the equivalent time for the prf in ms is given. Below this control is a green box which controls the Therapy Parameters. These parameters are the same as in Sec. 2.2.1 with two additional options: *Lines Before* and *Lines After*. These options represent how many A scans to take before and after the therapy burst.

Below the Therapy Parameters box is a button to *Set Panametrics*. When this is chosen the vi *5900PRSet.vi* opens (Fig. 8). The options in this vi are the same as those available on the 5900PR. Changes can be made directly on the instrument without effecting any of the vi discussed here. *5900PRSet.vi* is provided because it is somewhat more convenient to use than the actual front panel of the instrument. Once the settings of the 5900PR are selected, push *Done* to return to *AcqCont.vi*.

The next control, *Set Digitizer*, is discussed in more detail in Sec. 2.3. Before taking data for the first time, this option needs to be selected. A new vi will open, allowing a rf sampling window to be selected. Once the digitizer is set up, data can be acquired by pushing *Start Scan*.

Once *start scan* is selected, data is acquired and displayed in the figure on the right side of *AcqCont.vi*. Under the plot are two controls. One allows the data to be represented as a linear compression or a log compression. The other control allows the axis to be scaled to a distance, rather than a count.

The controls above the plot select the naming convention of the files and allow data to be saved. *Case name* selects the root name for the files. It can be changed at anytime. As data is taken, a scan number is appended to the case name, always starting with 1 for a new case name. Previous scans can be viewed by selecting the appropriate case name in the pull down menu below the *Save All Data* button. They can also be viewed as a collection of thumbnail images by selecting *View Thumbnails*. When this option is selected, another vi opens up in the background (*Thumbnails.vi*). *Thumbnails.vi* will display thumbnail scan images with an overlaid file name as data is taken.

When the data is ready to be saved, pressing *Save All Data* initiates the process. If you do not want to save all of the cases, press the red *keep?* button next to the appropriate case so that it is not

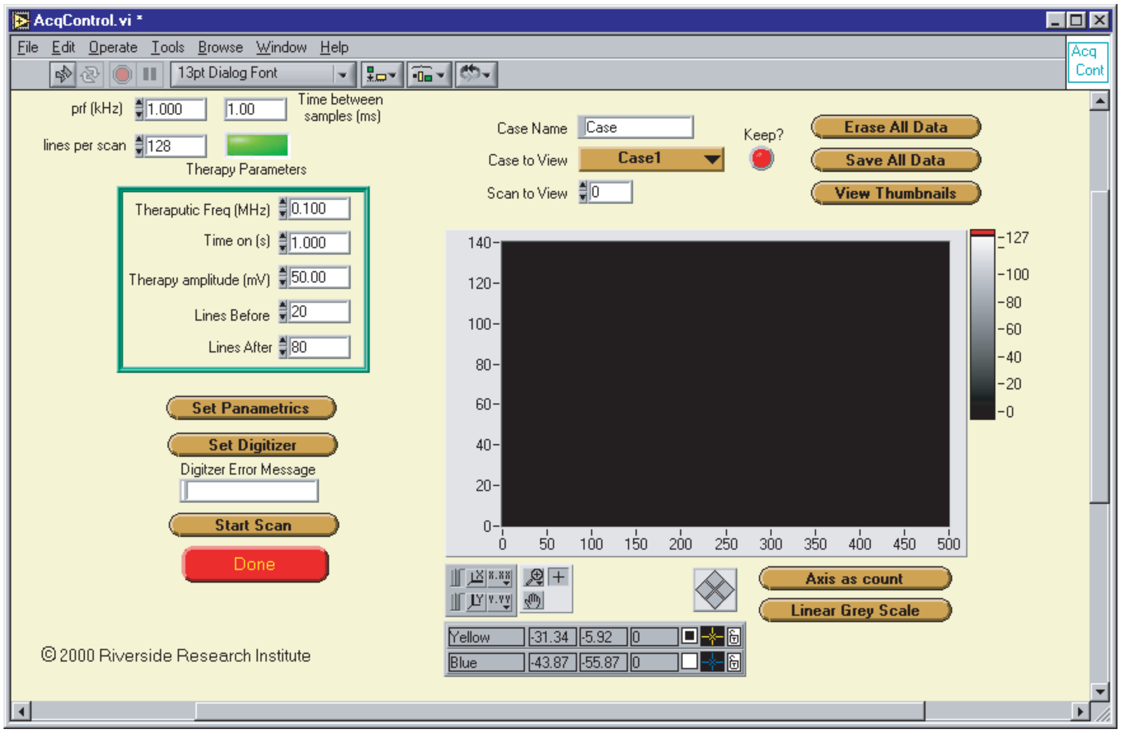


Figure 7: Control panel for *AcqCont.vi*. The controls on the left side relate to input parameters and the controls on the right side to viewing and saving acquired data. The left side controls will vary depending on what scan mode is selected.

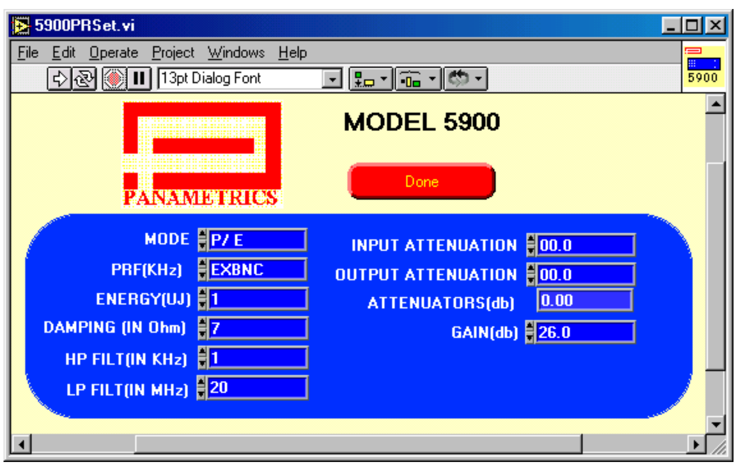


Figure 8: Control panel for *5900PRSet.vi*. This vi accesses the same option that are available on the front panel of the 5900PR.

lit. **You must choose which cases not to save before pressing** *Save All Data*. The default setting for each new file is to save it. A new vi opens up (Fig. 9) showing all the header information that will be saved with the EYE file. Most of the fields can be changed at this point except for items that were fixed upon scanning (Sample Rate, # rf points per line, RF file name, Patient ID,

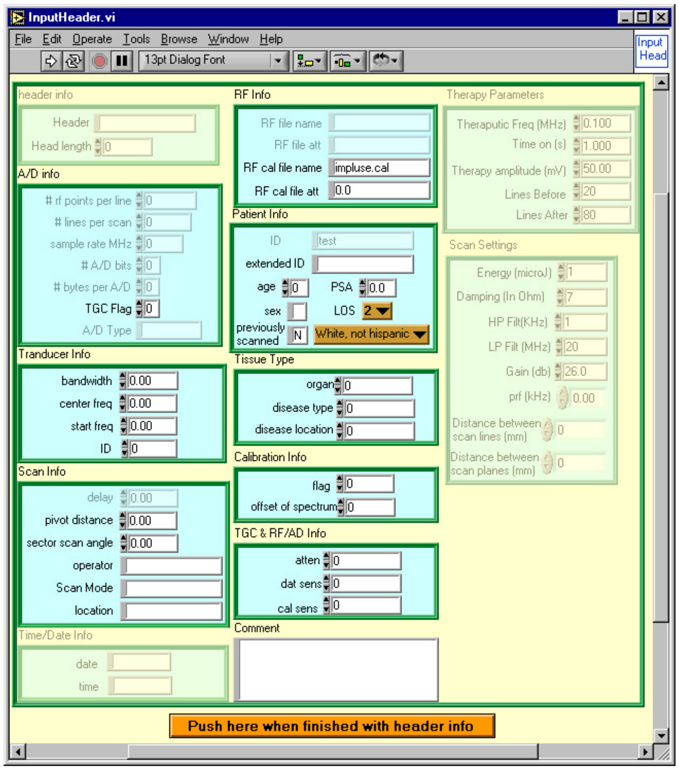


Figure 9: Control panel for *SaveData.vi*. This vi allows the user to select parameters in the EYE file header before EYE files are saved.

etc). These items are grayed out to indicate they cannot be changed. When ready to save the files press the button labeled *Push here when finished with header info* at the bottom of the vi. All the data is saved to the D:\Temp directory.

To delete all of the acquired data, press *Erase All Data*. To enter a different scan mode or to exit the program, press *Done* and return to *mastercontrol.vi*.

2.2.3 M Scan

The M scan mode differs from the above section only in the choice of input parameters. Figure 10 shows the upper left corner input parameters available in *AcqCont.vi*. The choices now are just for *prf* and *lines per scan*. Digitizer settings may also need to be changed, but that is discussed in a later section.

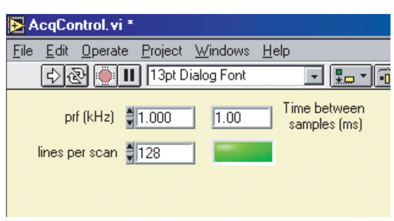


Figure 10: Input parameters for *AcqCont.vi* when in M Scan mode.

2.2.4 M Scan With Therapy

The options in *AcqCont.vi* look the same as in Fig 10. The therapy parameters are chosen in the vi activated by selecting *Set Digitizer*. A green light will indicate that the total number of data points is valid. If the indicator turns red, the number of RF points of number of scan lines needs to be reduced until the display turns green again. The therapy mode for this and in the next sections now differs slightly from the ones in Secs. 2.2.1 and 2.2.2. The therapy is now slaved to a divide down circuit linked to the prf. A divide down factor (n) is chosen for the prf, and then the therapy is fired every n triggers. Unlike before, the therapy is limited to a maximum of 50000 cycles.

2.2.5 1-D B Scan

As in the previous mode, the input parameters change slightly when 1-D B Scan is selected (Fig. 11). Now you choose the spacing between scan lines instead of the prf. The total distance of the scan is displayed based on the *lines per scan* and *Distance between scan lines (μm)*. The prf source will now be derived from the motors. All previous modes used the function generator as the prf source.

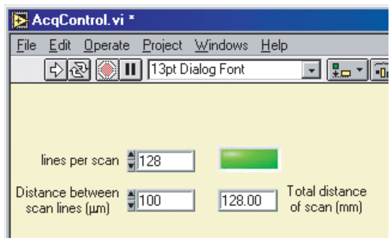


Figure 11: Input parameters for *AcqCont.vi* when in 1-D B Scan mode.

2.2.6 1-D B Scan With Therapy

This mode looks just like 1-D B Scan except now a therapy burst can be fired with a divide down setting.

2.2.7 2-D B Scan

In the 2-D B Scan mode, a few more parameters than in the 1-D B Scan mode are available. Now the user must select *number of scans* and the *Distance between scans (μm)* (Fig. 12). These settings determine the number of scan planes and the distance between the scan planes.

This case differs slightly from the earlier modes because each scan generates multiple data sets. The *case name* now represents a 2-D scan where each case has multiple scan planes. A number is still appended to the Case Name for each new scan, but now a letter **a** is added to the end of it. (Case1a is the first scan, Case 2a is the second, etc.) To view the individual scan planes for each case, the *Scan to View* control is incremented to the appropriate scan plane number. Note that the number starts from 0 not 1. To view a previous case, the menu control below *Save All Data* is still used. Now when the data is saved, the data from each case retains its case name (Case1a) and the scan plane number is appended to the end of this name. For example, Case2a003 would be the third scan plane of Case2a.

2.2.8 2-D B Scan With Therapy

This mode looks just like 2-D B Scan except now a therapy burst can be fired with a divide down setting.

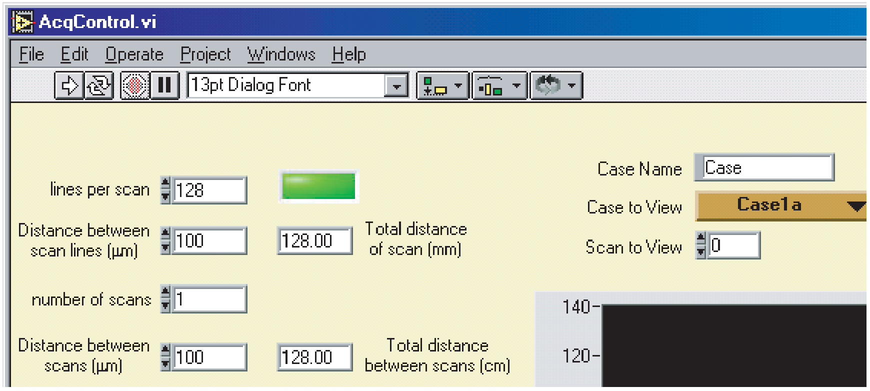


Figure 12: Input parameters for *AcqCont.vi* when in 2-D B Scan mode. A control is now available to select which scan plane to view.

2.2.9 Rotational Scan

This mode uses a fourth axis that rotates a specimen while scanning. The probe remains fixed while the specimen rotates. This mode also permits 2-D scanning in multiple z-axis planes. This mode is only available with the NI based systems. The mode permits the scan angle to be selected in 45 ° increments and the number of scan lines are selected with a pull down menu. A red light will turn if an invalid combination is used or if the number of data points exceeds the hardware capability.

2.3 Setting up Digitizer

When the *Set Up Digitizer* control is selected in *AcqCont.vi*, the vi *SetUpDigi.vi* opens (Fig. 13). *SetUpDigi.vi* allows the user to select a RF window for digitization. The vi functions much like an oscilloscope but with a few additional control parameters. The vi is divided into three zones, Digitizer Settings, Therapy Burst Set Up, and an active display of the RF signal.

The Digitizer Settings are all enclosed within a green border which contains several sub-units, also enclosed in green boxes. The RF data Sampling parameters select what region of the active display will be digitized in *AcqCont.vi*. *Sampling Rate* and *rf points per line* select the data region to digitize which is represented by the data between the Yellow and Red cursors in the active display. *Ref Delay (μs)* selects a delay relative to the PRF trigger and selects the first point in the active display. The *Ref Delay (μs)* combined with the location of the Yellow cursor result in a value for *Equivalent delay distance (mm)* and *Total Delay (μs)*.

The remaining Digitizer Settings function much like the controls on an oscilloscope. Scale Settings select the vertical and horizontal parameters of the Acqiris DP110. *Voltage Scale* represents the full digitization range of the DP110 with 5 V_{pp} being the maximum allowable parameter and 50 mV_{pp} the minimum. *Coupling* represent the channel coupling and needs to be either DC 50 Ω or AC 50 Ω. *Time Scale per Div* represents time per division in the active display with a total of ten divisions. Therefore the total duration of the displayed RF signal is 10 times the value of *Time Scale per Div*. The final Digitizer Settings are for the trigger source and will normally not need to be adjusted. The default values are for an external, 1 MΩ DC coupled source that triggers the DP110 on its rising edge with a 100 mV level.

The text box labeled *Error Message* will normally say something like **Triggered Successfully**. This indicates that the DP110 is functioning properly. If some other message appears, then a problem may be present in the system. If a message saying **Triggers Missing** appears, then the trigger source on the switch box is likely set to Motor PRF or a BNC cable is not connected properly.

The active display will show the RF signal and the data region selected for digitization. The Red

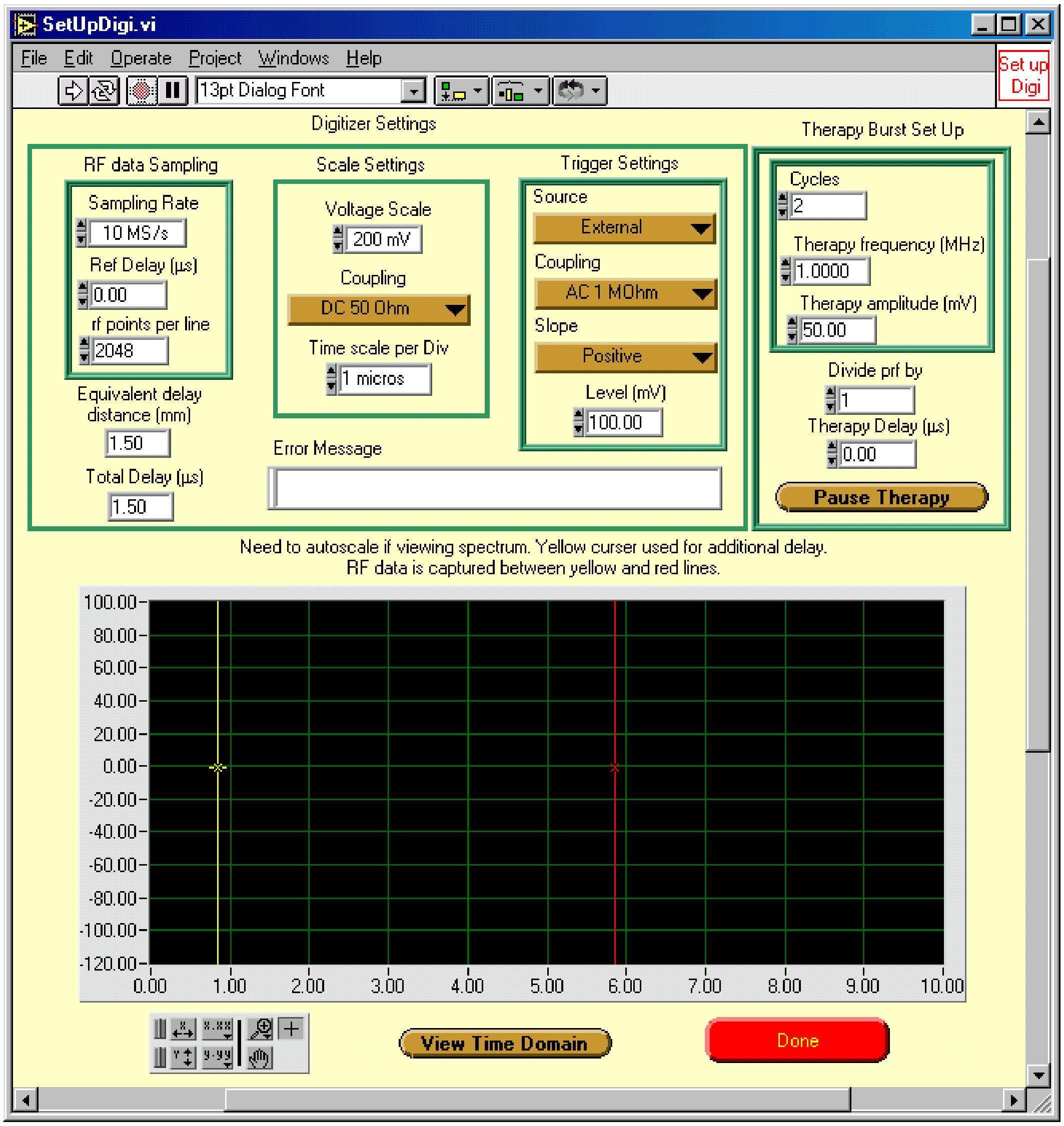
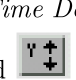


Figure 13: Control panel for *SaveUpDigi.vi*. This vi selects what region of the RF signal to capture. The data between the yellow and red cursors is the data that will be digitized. *Sampling Rate* and *rf points per line* select the "length" of data. *Ref Delay (/mus)* and the position of the left cursor select the first data point. Therapy settings are only available if a Therapy scan mode was selected.

cursor is slaved to the Yellow cursor based on the values of *Sampling Rate* and *rf points per line*. The Yellow cursor can be moved by selecting it with the mouse and dragging it to a new position. The scales for the active display are in mV and units of the selected *Time Scale per Div*. The spectrum of the full RF signal can be viewed by selecting *View Freq Domain* rather than *View Time Domain*.

When a spectrum view is chosen, the axis need to be re-scaled by pushing  and  in the control below the active display.

The Therapy Bust Set Up controls are only displayed if a therapy scan mode is being used. The therapy is limited here to a maximum of 50000 cycles. The therapy is fired every n counts of the PRF as selected in the *Divide prf* control. The therapy delay represents a delay in the therapy burst relative to the PRF trigger. *Therapy frequency (MHz)* and *Therapy amplitude (mV)* are just what they appear to be. The therapy bursts can be momentarily stopped by pushing *Pause Therapy*. The control will then read *Therapy Off* and when it is pushed again, the therapy bursts will return.

Once a region of the RF signal has been selected for digitization, pushing *Done* returns to *AcqCont.vi* and scan data can be acquired.

3 Transducer Characterization

The vi *TestTrans.vi* (Fig. 14) operates in a similar fashion to *manualcontrol.vi*, but is designed to characterize a transducer beam. The main difference between the two programs is that *TestTrans.vi* extracts a parameter from each scan line (such as negative peak voltage) and then displays it. The controls in Fig. 14 will be discussed from left to right, focusing mainly on features not yet discussed. **The connections change slightly because the DP110 Channel 1 input is now meant to be from a hydrophone.**

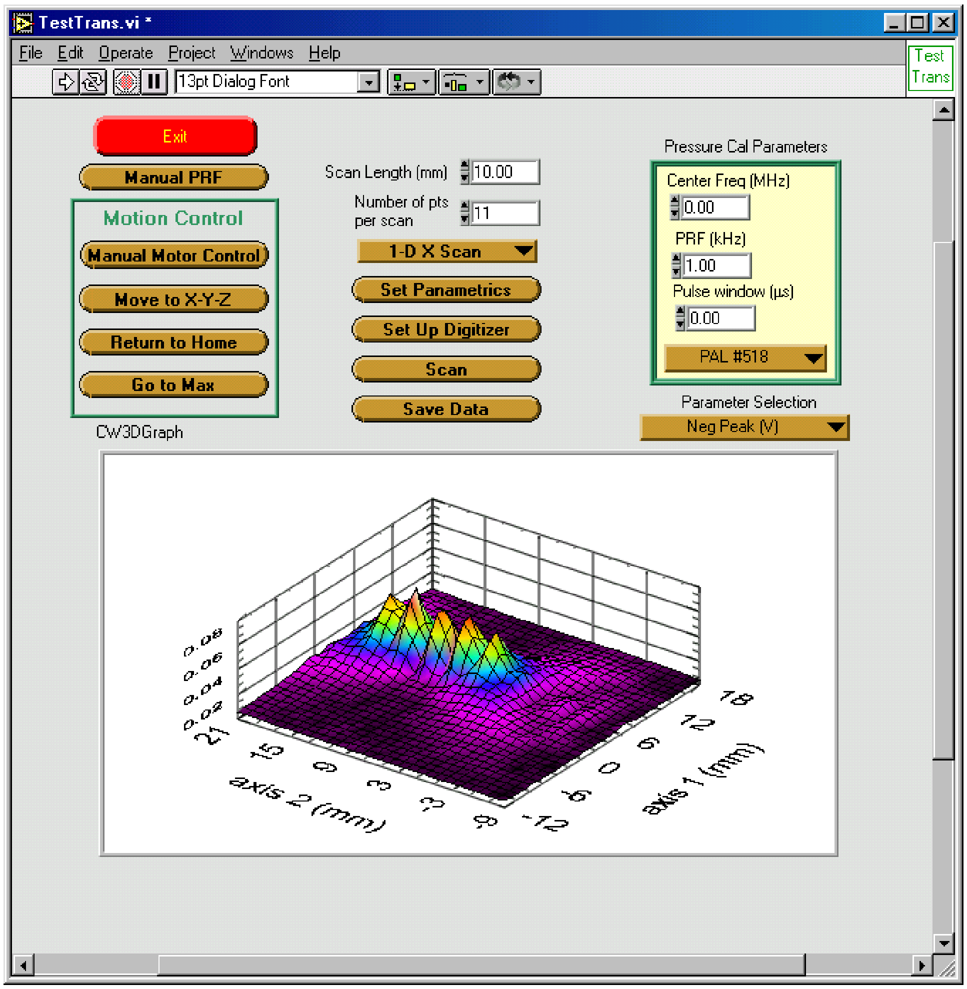


Figure 14: Control panel for *TestTrans.vi*. This vi allows for the characterization of a transducer beam. Both 1-D and 2-D scans are possible. The vi is designed to work with a calibrated hydrophone, permitting the voltage data to be converted to pressure. The transducer can be operated in continuous wave, burst, or single pulse modes.

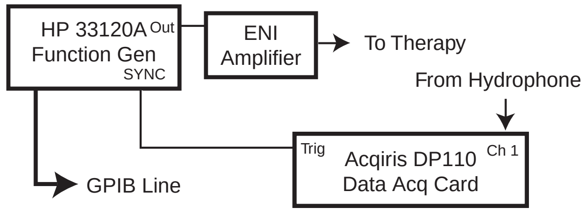
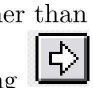


Figure 15: Wiring diagram for equipment when using *TestTrans.vi* with a therapy transducer and hydrophone. The function generator is the one with GPIB address 11.

There are two options for the prf. The first mode is when the 5900PR is used to examine the pulse from diagnostic transducer. This mode is selected when the control found under the *Exit* button reads *Manual PRF*. In this mode the HP33120A with GPIB address 11 is manually controlled to originate a PRF signal. The system wiring is like in Fig. 1 except the input for Channel 1 on the DP110 is from the output of the hydrophone pre-amplifier instead of from the RF output of the 5900PR.

The second mode of usage of *TestTrans.vi* is when a therapy type transducer is being characterized. For this mode, push the *Manual PRF* button so that it reads *Burst Mode*. The PRF still comes from the SYNC output of the HP with GPIB address 11 but now the output is a tone burst, generated by HP with GPIB address 10, is used to drive a therapy type transducer. The settings for the tone burst are selected via the vi rather than directly on the function generator. The system BNC wiring changes for this case are shown in Fig. 15.

Like before, the input to Channel 1 of the DP110 is connected to the hydrophone output. The burst mode parameters are selected in *Set Up Digitizer* (Fig. 13). Only the Therapy Burst Set Up options for *Cycles, Therapy frequency,* and *Therapy amplitude* will have any effect. Also make sure the Trigger Settings has a Negative slope selected and that the coupling is set for AC 50 Ω. This will ensure that the DP110 triggers at the start of a burst rather than the end of a burst.[1]

Like for *manualcontrol.vi*, *TestTrans.vi* is started by pushing . After executing the vi, the Motion Control options are available with one new addition: *Go to Max*. *Go to Max* moves the transducer to the maximum parameter values after taking a 1-D or 2-D scan. This provides a means of moving the transducer to the position of maximum acoustic pressure. **Only select** ***Go to Max*** **once after each new scan**.

Before taking data, a region of the RF signal needs to be selected for digitization by using *Set up Digitizer* (Sec. 2.3). The parameters of the 5900PR can also be adjusted with *Set Panametrics*. Now a transducer scan can be taken. Select a *Scan Length (mm)* and *Number of pts per scan* and the type of scan. The type of scan is chosen with a pull down menu (Fig. 16). The start position of the transducer is always the center point for any scan. Pushing *Scan* will start the scan. The PRF source from the switch box can either be from the function generator or from the motor PRF.

Once a scan is taken, the data is displayed in the plot of *TestTrans.vi*. If the scan was 1-D, then a normal 2 axis plot is displayed. If it was 2-D, then a 3-D plot is used. The axis of the plots are in mm. The vertical (intensity) parameter is chosen with the pull down menu labeled *Parameter Selection* (Fig. 17). The vertical parameter is always shown as an absolute value and can be actively changed by changing *Parameter Selection*.

The first four options of the parameter selection (Neg Peak, Pos Peak, Peak to Peak, RMS) are exactly what their name implies. The remaining parameters relate to definitions in the FDA 510(k) guidelines and require inputs from the *Pressure Cal Parameters* control (Fig. 18). **The parameters need to be selected before scanning.** Except for Neg Peak Pressure, they should only be used with a pulsed transducer. The *Center Freq (MHz)* needs to be determined by examining the spectrum of the signal in *SetUpDigi.vi* (Sec. 2.3). *PRF (kHz)* is the PRF setting on the function

[1] The SYNC HP33120A drops low when the burst takes place, thus the need for a negative edge trigger.

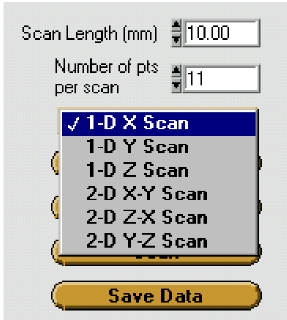


Figure 16: Pull down menu for scan type in *TestTrans.vi*

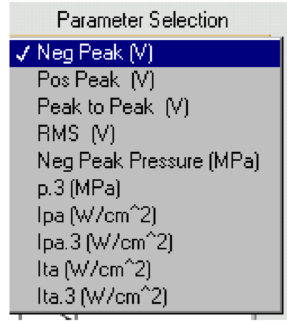


Figure 17: Pull down menu for scan type in *TestTrans.vi*

generator. *Pulse Window (μs)* determines the data window to compute the pulse parameters. Use *SetUpDigi.vi* to see what time duration the pulse lasts. Finally, select which Precision Acoustics Lab hydrophone is being used.

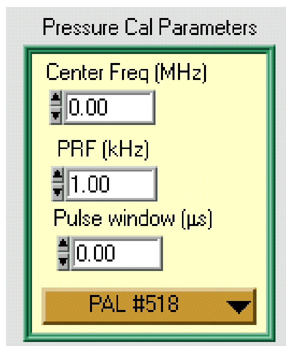


Figure 18: Input selections to obtain 510(k) parameters for transducer scan.

The parameters related to the Pressure Cal Parameters are computed from several parameters. The negative peak pressure P_{min}, a derating factor a=0.3 dB/(cm MHz), and the pulse intensity integral (PII)

$$PII = \int_{t_0}^{t_1} I(t)dt, \tag{1}$$

where $t_1 - t_0$ is *Pulse Window* and $I(t)$ is the instantaneous pulse intensity ($I = p^2/\rho c$). From these parameters we then find the pulse-average intensity $I_{pa} = PII/(t_1 - t_0)$ and the temporal-average intensity $I_{ta} = PII/PRF$. Derated values are then found by multiplying the pressures by a and the intensities by a^2. The path length used to compute a is assumed to be the separation between the source and hydrophone. This may not relate to the physical conditions in which the source is actually used.

4 Viewing EYE files

Use *ViewEyeFile.vi* to view an EYE file once it has been saved to disc. This program will automatically create a sector scan image if appropriate. A region of the EYE file can be viewed as a 3-D intensity plot or as a single scan line can be displayed as RF data. The region to view is selected with movable cursors in the EYE file. The header info can also be viewed.

4.1 Viewing a batch of EYE files as thumbnails

To view a batch of saved EYE files as a collection of thumbnails use *ViewPicts.vi*. When this program is executed, the user is prompted to select a directory. Choose the directory, then select the files to view in the list box display. When all the files are selected, push *Use Selected Files*. After a short time the thumbnails will be displayed with the file name overlaid on the image. If the EYE file was a sector scan it will be converted to a sector format.

5 Altering Headers

The VI *AlterHeader.vi* allows fields in a batch of EYE files to be changed. The files that will be changed are selected like what was discussed above in *ViewPicts.vi*. The fields that get changed need to have a check in the box to their right and a new value entered before pressing *Use Selected Files*. For example, the case in figure 19 has two fields selected with check marks: # rf lines per scan and sample rate MHz. When *Use Selected Files* is pushed, the selected EYE files (rri.eye for this example) will have their header updated with the new values.

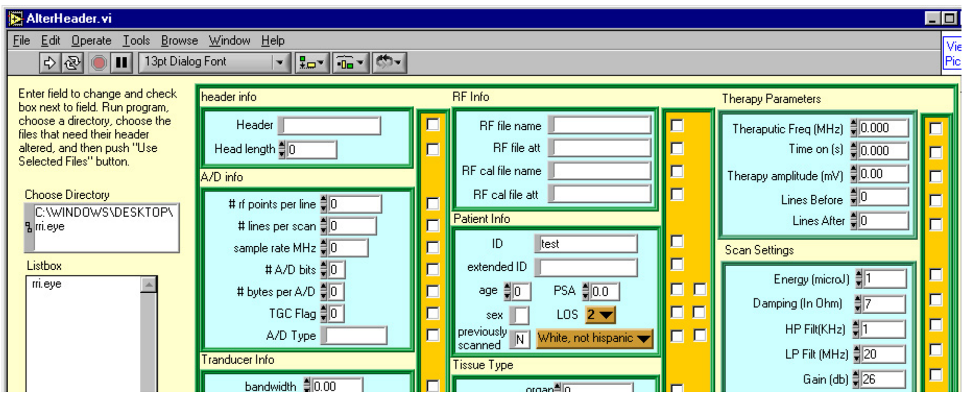


Figure 19: Control panel of *AlterHeader.vi* which allows fields in the header of EYE files to be added or changed.

6 3D image prep

There is now one application to prepare data for plotting in 3-D (*3DVisPrep.vi*). The NoEsys software component T3D seems to be the easiest application to view volumetric data. To read data directly into T3D, it can be saved as a byte file or as ASCII text. All data planes are saved in one file. The data can then be read into T3D and the dimensions of (X, Y, Z) are entered. RGB bitmap planes can also be converted to a single byte file.

The program asks for the root file name of all the planes, the number of planes, and the directory of the files. For example, if the data is in spreadsheet format and name *plane1.txt* and *plane2.txt*, the root file name is plane and the number of files is 2. **Spreadsheet files need to end with *txt* and RGB BMP files with *bmp*.** The user chooses what kind of conversion to make and the output is saved to the chosen file name. The output files are numbered if more than one is generated.