Physical Property Lab
IMS VS CookBook

1. Introduction

The IMS VS (Velocity-Strength) application provides integrated control and data acquisition for the measurement of acoustic velocity and shear strength. IMS VS was developed in LabVIEW, a graphical programming language created by National Instruments. It is specifically designed to meet the needs of SCADA and MMI (Supervisory Control and Data Acquisition and Man-Machine Interface) Applications.

IMS VS provides all of the functional controls for real time data collection and display, as well as utilities for setup, calibration, file writing, and system trouble shooting.

1.1 IMS VS Subsystems

Several subsystems enable the IMS VS system to measure velocity, strength, and core position. These consist of:

1. PCI 4A encoder interface board. Provides the interface to three encoders (one used for positioning and two for the Vane Shear).

2. GEOTEK P-wave logger. Provides acoustic pulse for the PWS stations (Used with the Multi Sensor Track MST and not under IMS VS control).

3. Linear Voltage Displacement Transducer (LVDT). Measures transducer displacement for PWS3.

4. National Instruments oscilloscope boards. Used to digitize the received acoustic signal from the PWS stations (one for PWS1 and 2 and one for PWS3 and displacement from LVDT).

5. OMEGA DP41-TC meter and type K thermal couple. Used to measure core temperature during PWS measurements.

1.2 Velocity

Velocity measurements consist of three stations that measure the compressive, acoustic velocity in the three orthogonal directions. Two stations, labeled PWS1 and PWS2 measure the z-axis and y-axis respectively. The transducers are mounted at the end of two stainless blades so that they can be inserted into soft sediments. The third station labeled PWS3 measures the x-axis on half cores and all three axes on mini cores and cubes. PWS3 is the replacement for the Hamilton Frame and can be used on both firm sediment and hard rocks.

Velocity is calculated by dividing the separation distance of the transmitting and receiving transducers by the time for the acoustic pulse to travel between the two transducers. Corrections are made for electrical delay. If the measurements are made through the core liner, then corrections are calculated and applied for liner delay and core liner thickness.

The transmit signal is a 500 kHz 100 V peak-to-peak square wave, pulsed sixty times a second. Two digital O-scope boards are used to digitize and stack the received waveform. The O-scopes display the waveforms on the OMS VS main control panel. The travel time is measured from the initial pulse to the first arrival of the receiving transducer (time break). The time break can be chosen by IMS VS automatically or picked by the user.

The transducer separations of PWS 1 and 2 are fixed at 69.65mm and 34.85mm respectively. The separation between the transducer pair for station PWS3 is adjusted to the thickness of the core half or mini-core/cube. The separation is measured by a LVDT (Linear Voltage Displacement Transducer). To secure accurate separation measurements, PWS3's lower transducer is mounted solidly to a plate on the countertop. However, the lower transducer can be raised and lowered with the use of an air lever pressure gauge. For calibration purposes, this transducer should be either in the raised or lowered position depending on how it is set during calibration. The technicians have shut off the gauge with the transducer in the lowered position in order to keep this as standard for calibration.

1.3 Strength

Strength measurements are made with a modified Wykeham-Farrance Vane apparatus referred to as the Automated Vane Shear (AVS). The AVS modifications involved the addition of two encoders to measure the rotation of the applied stress to the vane and the actual rotation of the vane while imbedded in the sediment. The encoders can measure to a precision of .09 which exceeds the precision of the spring and vane calibrations.

The measurement technique assumes an "undrained" fine-grained marine sediment (unlithified) sample and employs a vane shear rotational speed of 90 per minute. The torque applied to the vane is measured before, during, and after shear failure o the sediment. From the rotational data, spring stress, and vane area, IMS VS calculates and displays a strain vs. stress graph in real time. The maximum torque recorded is the shear strength of the sediment.

Shear strength measurements can be made both parallel and perpendicular to bedding. Measurements parallel to bedding are performed on the split working half in areas of minimal disturbance. Measurements perpendicular to bedding require inserting the blade into a whole-round section.

NOTE: THIS TEST **MUST** BE DONE WITH THE AUTHORIZATION OF THE CURATOR AS IT AFFECTS THE ARCHIVE HALF OF THE CORE.

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2. Database and File Structure

2.1 JANUS Files

Standard definitions, calibrations constants, and measurement data are formatted and saved by IMS VS to files specifically designed for uploading into the JANUS database using the JANUS application.

WARNING! NEVER EDIT THESE FILES. CHANGING THESE FILES CAN CAUSE DATA TO BE LOST OR CORRUPTED DURING THE JANUS UPLOAD PROCESS.

Two copies of these files are saved. One copy is saved to the local hard drive as a backup. The second is saved to the DATA1 volume on the QUAKE server. You must enter the correct username and password when initially logging on to the computer to be able to write data to DATA1. See the Physical Properties lab technician or the system managers for help.

Within DATA1, IMS VS will open the JANUS_Q folder. Within the JANUS_Q folder the next level of folders are AVS, PWS1, PWS2, PWS3, and STANDARD.

> If the proper folders do not exist, then IMS VS will automatically create them without notifying you.

The AVS folder contains the following folders and data:
>SPRING: spring calibration data
>VANE: vane calibration data
>AVSssssh: shear strength sample and control data (ssssh = site hole)

The PWS1 folder contains the following folders and data:
>PWS1 CALIBRATION: calibration data
>PWS1ssh: PWS1 sample and control data (ssh = site hole)

The PWS2 folder contains the following folders and data:
>PWS2 CALIBRATION: calibration data
>PWS2ssh: PWS2 sample and control data (ssh = site hole)

The PWS3 folder contains the following folders and data:
>PWS3 CALIBRATION: calibration data
>PWS3ssh: PWS3 sample and control data (ssh = site hole)

The STANDARD folder contains the following folders and data:
>CONTROL: definition files for control standards
>LINER: definition files for the core liner (liner velocity and thickness values)
>PWS: definition files for PWS calibration standards

In addition, there is a folder named TRNFRD with the same folder structure as the JANUS_Q directory. When a data file has been successfully uploaded to the JANUS database, it will be moved from JANUS_Q to TRNFRD. Finally, there is a folder named ERRORS, also with the same folder structure, to which any file that cannot be uploaded will be transferred from JANUS_Q for later correction.

All files are uploaded from DATA1 to the JANUS database via the Generic Uploader, available on various computers in the core lab.

3. Getting Started

3.1 Launching IMS VS

Make sure that there are not any other programs running; it is easier on the computer. Also, be sure that you are logged in with a physical properties login and password to allow access to the DATA1 server. Double-click the ICON (Icon labeled shortcut to IMS VS.llb) and wait for the program to load. Once loaded, a dialogue box will appear, asking you to place the shuttle at the zero mark on the track and click MAKE IT SO. When this is completed, the main screen will appear.

3.2 Reading the Setup File

At this point the IMS VS will read its preference file. This file includes such information as the serial port settings, data file paths, constants' calibration values used in calculations, sample identification, and measurement parameters.

3.3 System Information
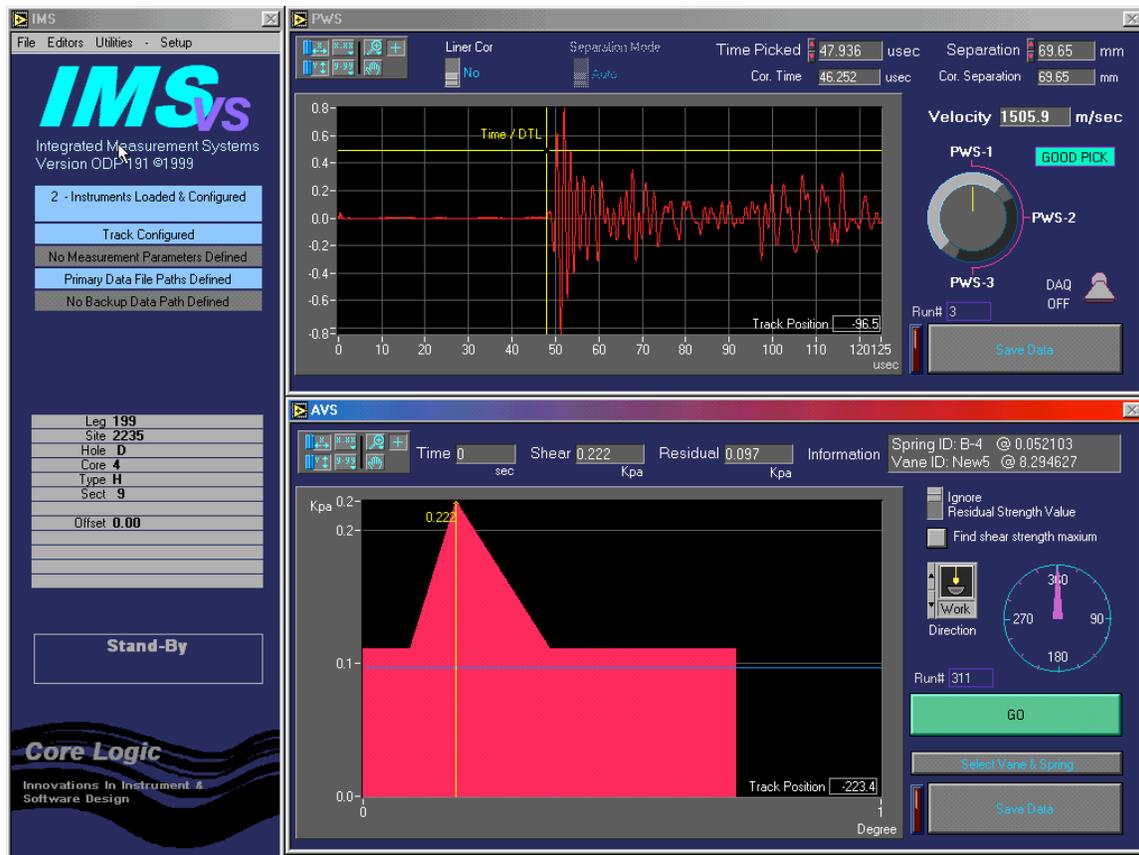
Main IMS Interface Screen

The first screen that will appear will be the main IMS interface (Figure 1). It is from this main screen that all other screens are accessed.

It is important that the hardware is properly connected so that the PWS station referenced in the software actually matches the PWS transducer pair.

The following is the standard setup for the PWS stations:

PWS1: The sensor should be set up in the z-direction with the transducers parallel to the core axis and cut surface.

PWS2: The sensor should be set up in the y-direction with the transducers perpendicular to the core axis and parallel to the cut surface.

PWS3: The transducers should be set up in the x-direction; the core liner will be resting on the lower transducer.

3.4 Equipment Status

Many of the communication protocols are fixed except for the serial port number.
Temperature Meter and Probe: Serial Port: Printer Port 1
PCI boards for the Shear Vane and PWS:
O-scope boards for PWS1 &2 and PWS3 & displacement:
Serial port communication parameter for the temperature meter is as follows:
Baud Rate – 9600
Data bits – 7
Stop Bit – 1
Parity – odd

3.5 Track Configuration

The positions for the PWS and AVS stations along the section are automatically determined for you but you have to move the section along yourself. The track should always be calibrated at the beginning of each leg and checked on a daily basis. The position of the shuttle relative to the selected sensor is displayed in the bottom right corner of each graph.

Track configuration is set up separately for the track itself, PWS1 &2, PWS3, and AVS.
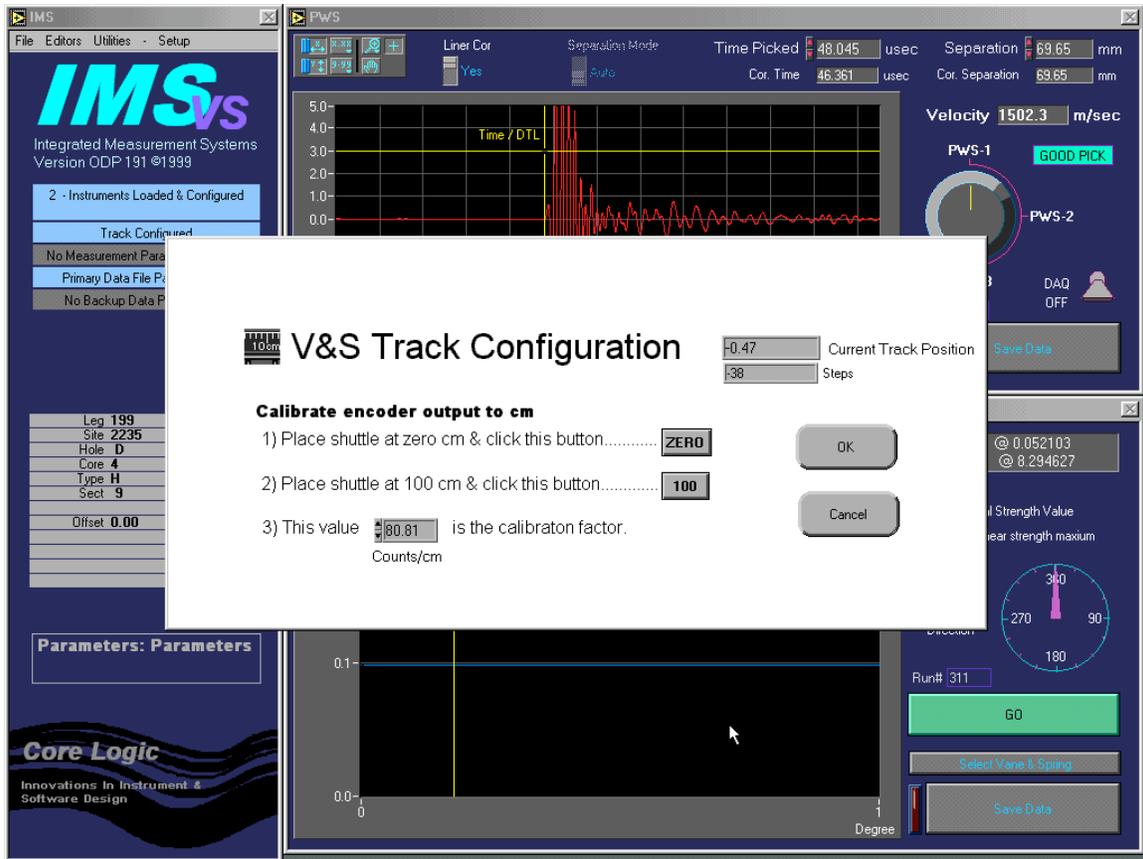
Figure 2. Zeroing the track.

The first thing you must do is to scale the encoder's output for the shuttle (Figure 2). Zero and 100cm indicators should be marked on the track.

To access:
1. Under SETUP on the main IMS VS panel, select PARAMETERS and then SAMPLE HANDLER
2. Move the shuttle (black cylinder with metal clip labeled SHUTTLE) so its clip is at the 0 cm mark and click ZERO. Now move the clip to the 100 cm mark and click 100 (the encoder output will automatically be scaled to centimeters)
3. Click OK to complete

Next, each sensor position must be configured.
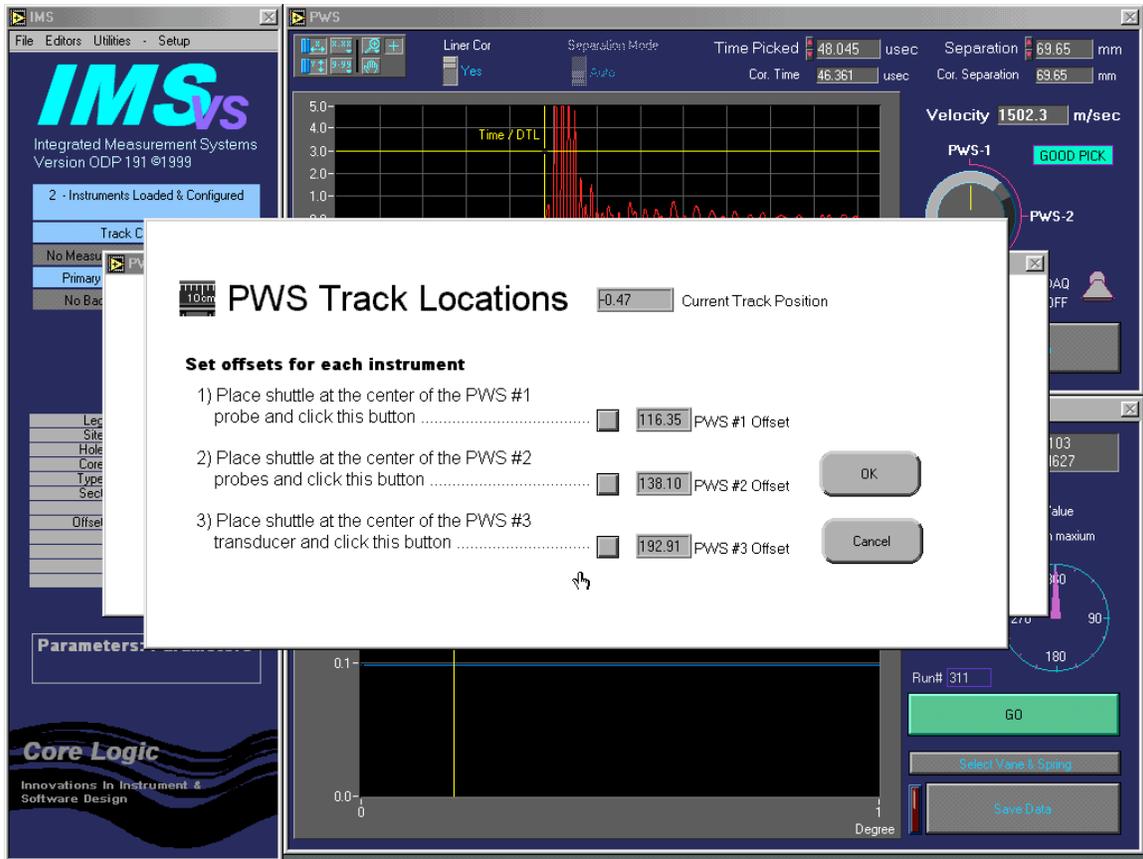
Figure 3. PWS Track configuration.

To access PWS1, PWS2 and PWS3 (Figure 3):

1. Under SETUP on the main IMS VS panel, select PARAMETERS then PWS and then Set Transducer Track Position.
2. Move the shuttle clip to center point between PWS1 transducers and click associated button
3. Repeat for PWS2 and PWS3
4. Click OK to complete
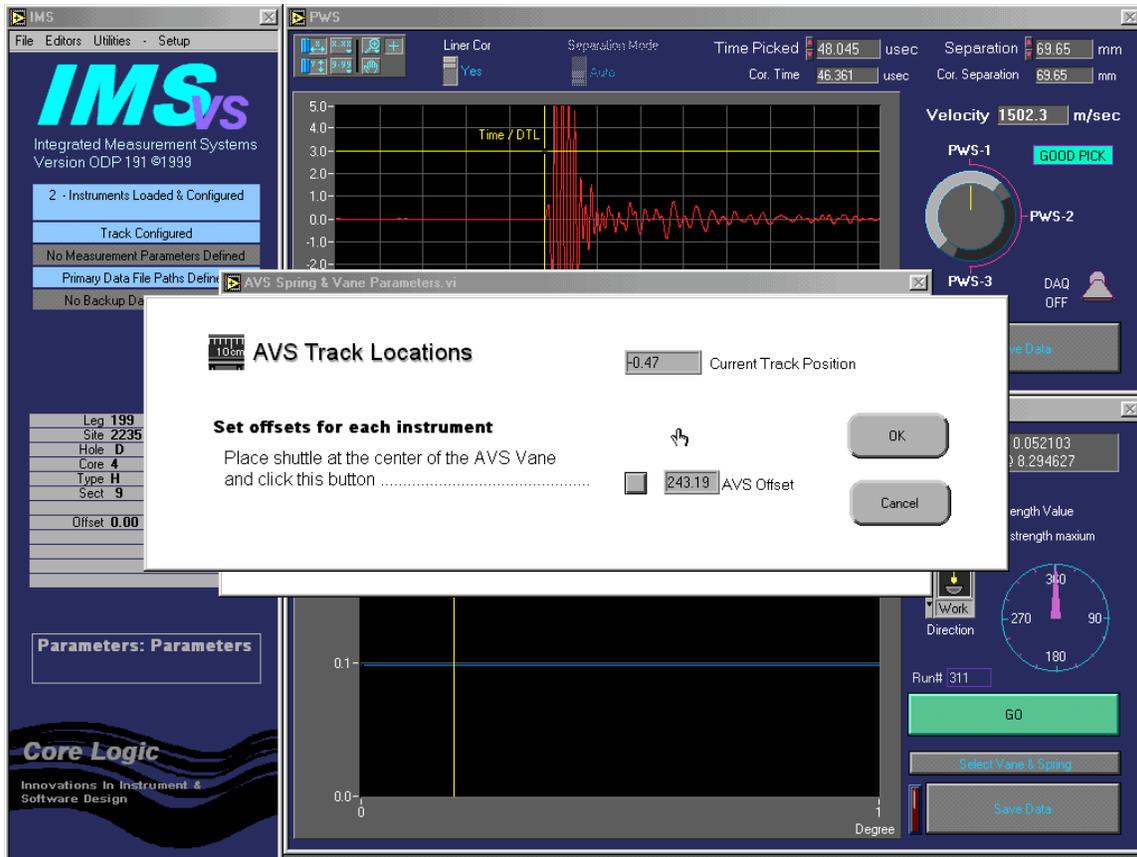
Figure 4. AVS Track Configuration.

To access AVS (Figure 4):
1. Under SETUP on the main IMS VS panel, select PARAMETERS then VANE SHEAR and then Set Vane Shear Track Position
2. Move the shuttle clip to center point beneath the vane and click the associated button
3. Click OK to complete

When taking measurements, clip the shuttle to the blue end cap (top of section). IMS VS will automatically provide the measurement position for the selected stations (displayed in bottom right corner of each graph). If by chance the track boat is not operational (or you are measuring cubes/mini cores from a specific interval), measurement intervals along the section can be made with a ruler and manually input into IMS VS.

3.6 Defining Standards

Before any calibrations or measurements can be performed, the control standards must be defined. Do this before each calibration. You must at least define core liner and velocity standards. These standards are used to determine the PWS electrical delay and core liner corrections.

3.6.1   PWS3 Calibration Standards

From the main IMS VS panel, under the EDITORS menu, select CALIBRATION STANDARDS EDITOR and then PWS. From the new panel, select DEFINE CALIBRATION STANDARDS. Figure 5 should appear on the screen.
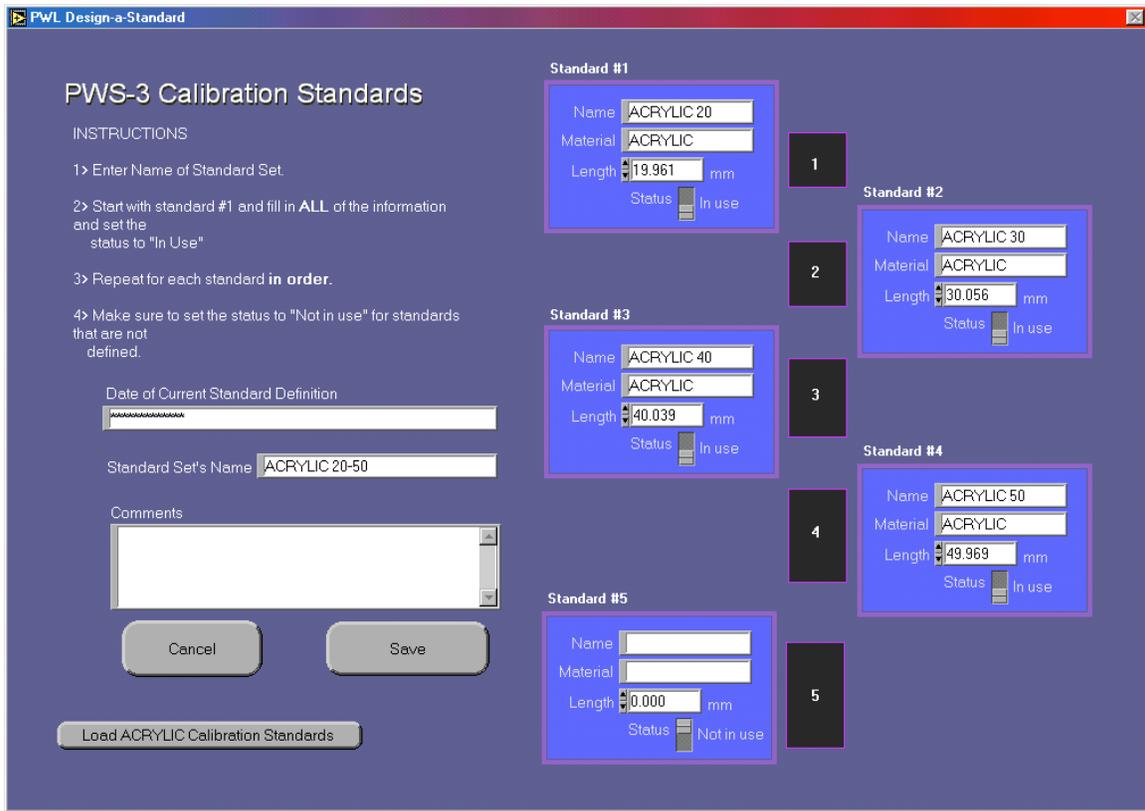
Figure 5. PWS3 Calibration Standards.

You may enter a name for the standard set and enter any comments in the comment window. All the standards in a set must be of the same material. Usually this is polycarbonate but other material such as aluminum can also be used. For each standard, enter its name and material, and toggle to "Iin use." You can define up to five standards in a set. If you define less than four standards, make sure that the unused definition boxes are toggled to "Not in use." Click SAVE when finished.

3.6.2   Control Standards

From the main IMS VS panel, under the EDITORS menu, select CALIBRATION STANDARDS EDITOR and then PWS. From the new panel, select DEFINE CORE LINER STANDARD. Figure 6 will appear.
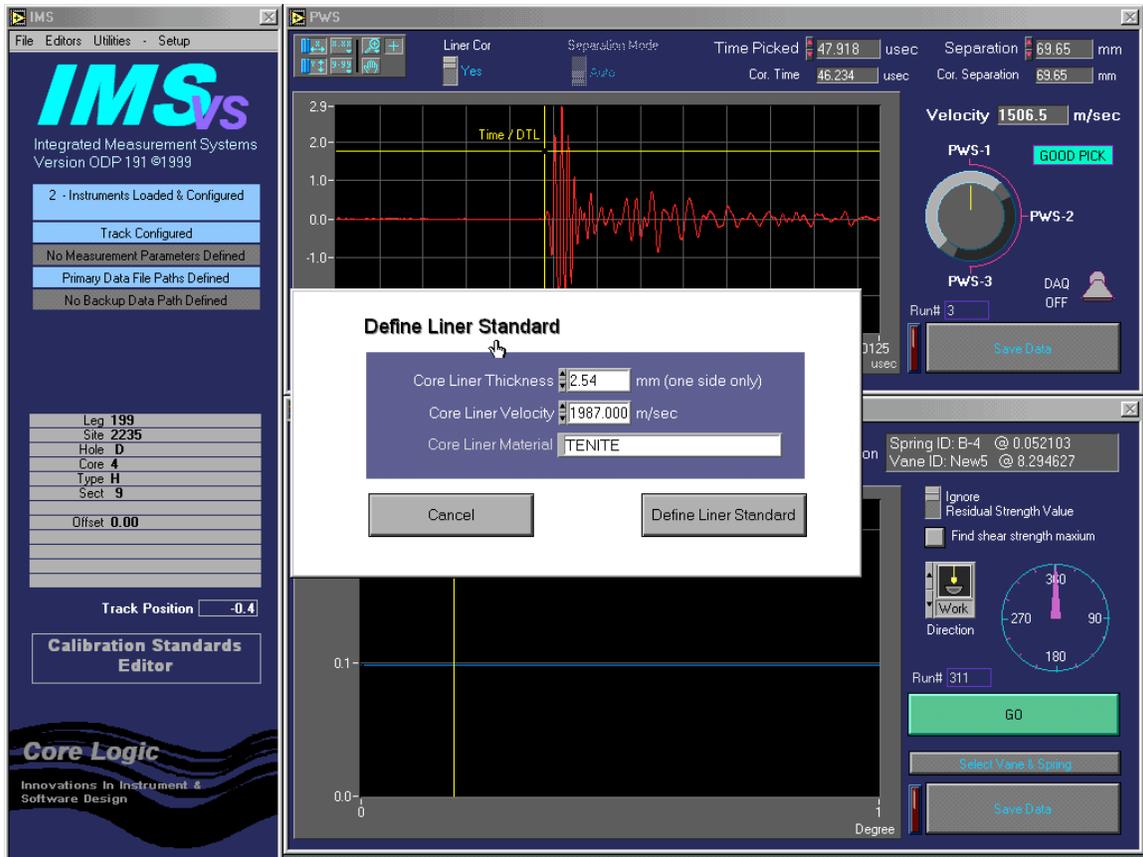
Figure 6. PWS Liner Standard.

Tenite is the core liner material and its velocity is 1987 m/s. Core liner thickness is 2.54 mm (one side of the liner). Click DEFINE LINER STANDARD to save the file.

The water standard is predefined and created automatically the first time a measurement is saved.

To define a new control standard, on the main IMS VS panel under EDITORS select CONTROL STANDARDS EDITOR. Figure 7 will appear.
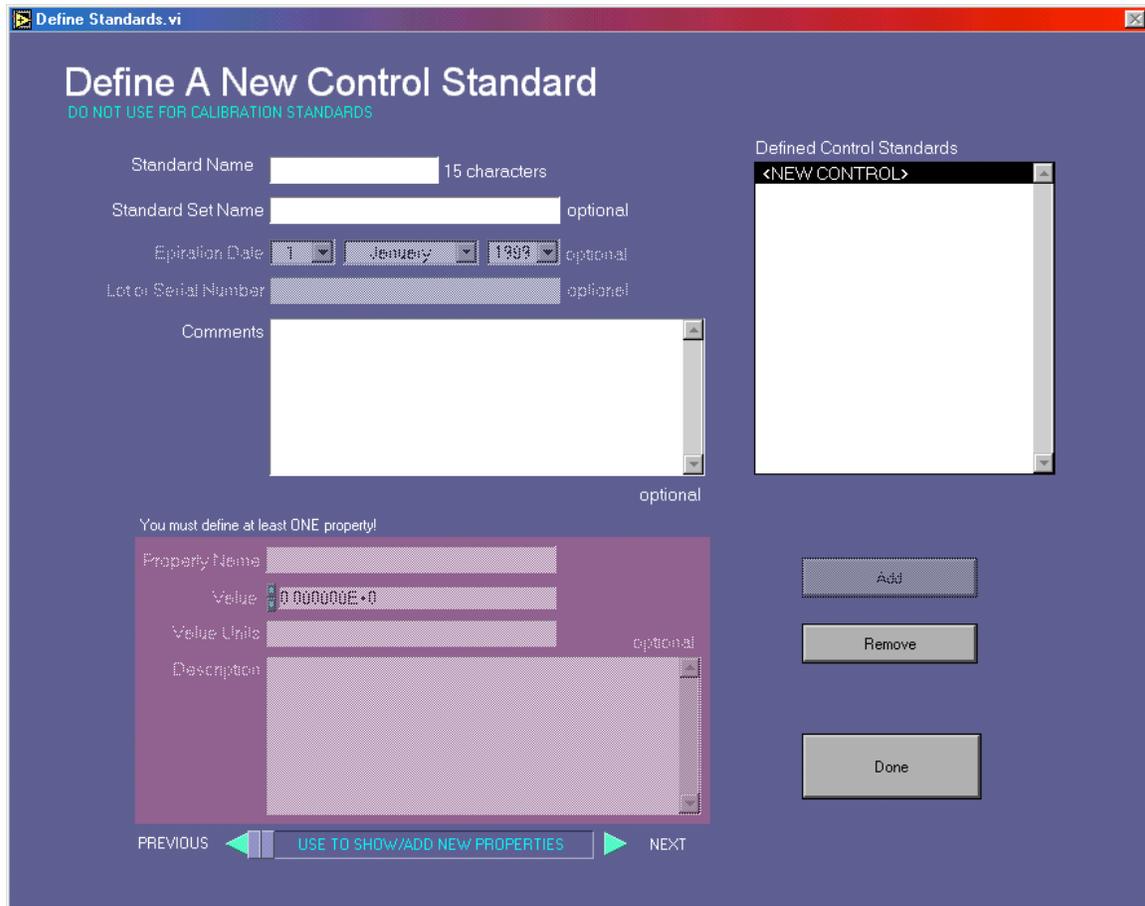
Figure 7. Defining new control standards.

3.7 PWS1 & 2 Calibrations

Calibrating PWS1 & 2 transducers consists of finding the delay time of the first arrival signal through distilled water, assuming a known value for the speed of sound in distilled water, corrected for temperature.

Use the following instructions:
1. On the main IMS VS panel, under SETUP select PARAMETERS, then PWS. The PWS Parameters Screen will appear (Figure 8).
2. From this screen select CALIBRATE PWS1 & 2; Figure 9 will appear
3. Fill the calibration boat (half core liner) with distilled water
4. Place the calibration boat under the PWS station to be calibrated
5. Lower the transducers into the water (via the air levers found to the right of the transducers). A waveform should appear on the graph on the screen. Be sure that the ACQUISITION lever is turned ON.
6. Insert the thermocouple probe into the boat, keeping it outside of the two transducers. Enter the value manually if required.
7. Turn the knob to select the PWS station you wish to measure
8. Double check the transducer separation (PWS1 = 69.65mm; PWS2 = 34.85mm)
9. Turn the ACQUISITION lever to OFF

The computer will pick the first arrival time and calculate the delay time. Alternatively, you can manually pick the first arrival time by dragging the vertical yellow cursor to the appropriate position. The computer will recalculate the delay time as you move the cursor and/or the temperature changes.

10. Click SAVE DATA to save the calibration file
11. Repeat instructions for second PWS station
12. Click DONE when finished
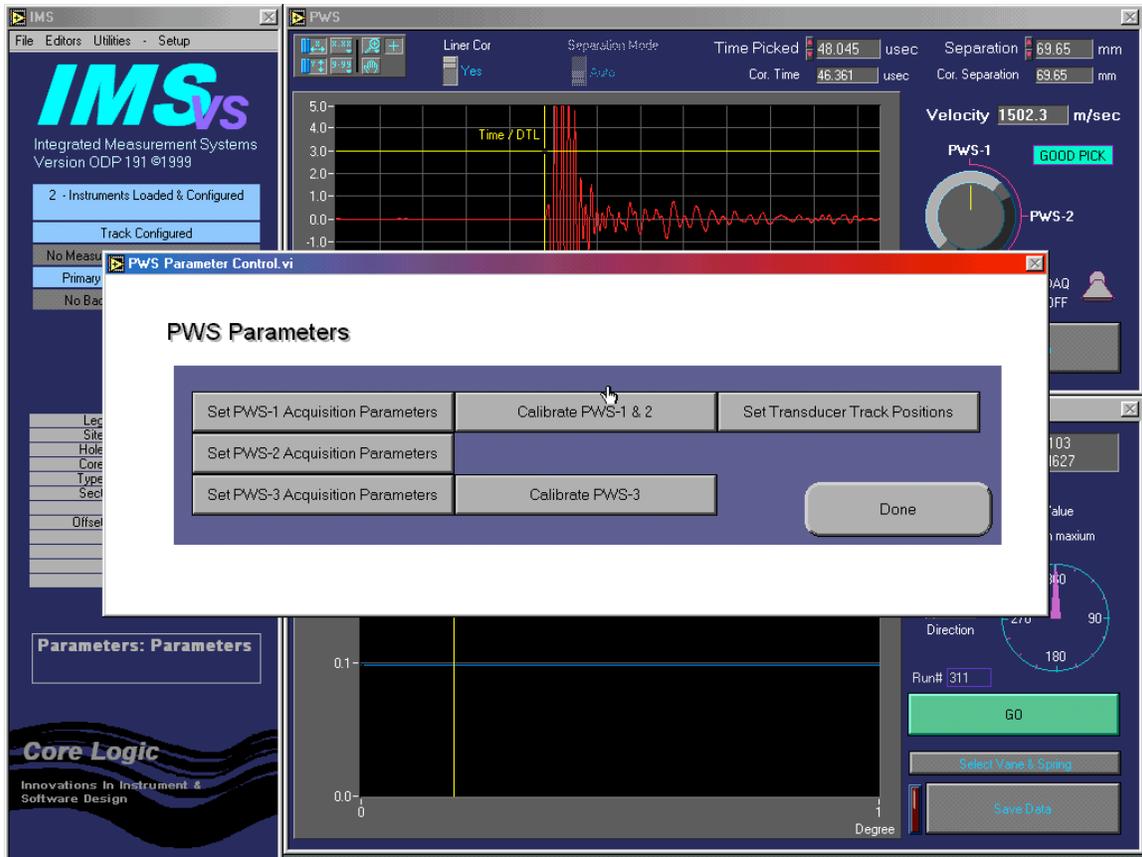
Figure 8. PWS Parameters.
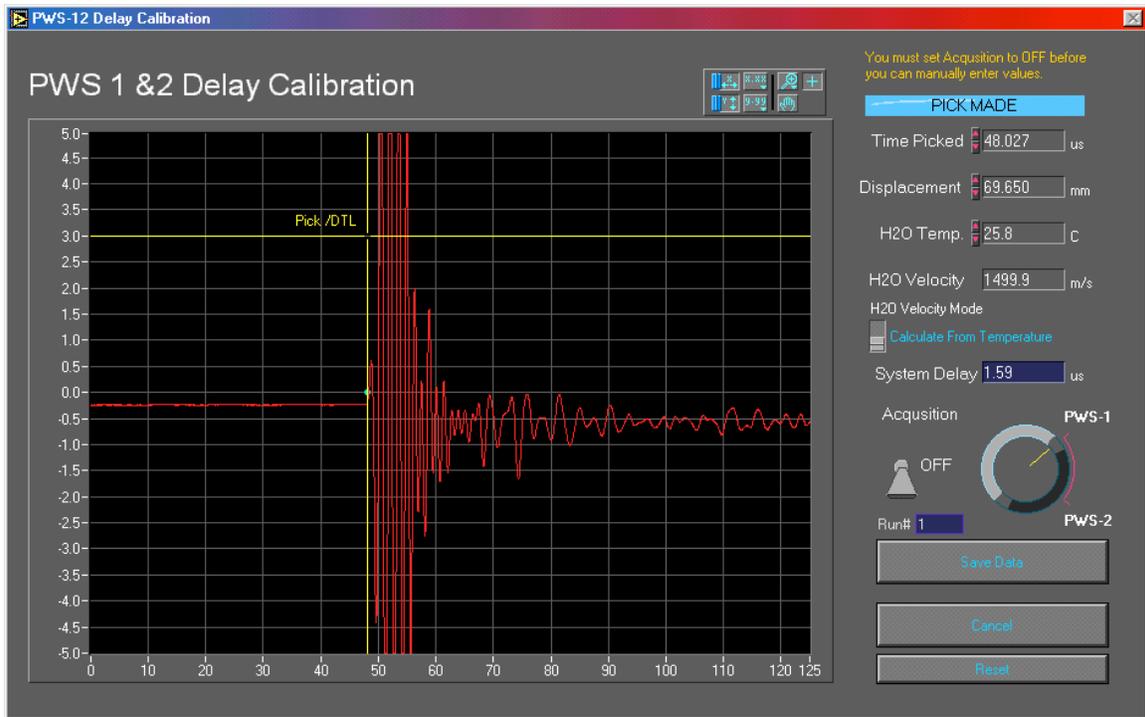
Figure 9. PWS1 & 2 Calibrations.

3.8   PWS3 Calibrations

PWS3 is calibrated by measuring a series of different length standards followed by a series of velocity measurements through distilled water. From the results of a linear regression applied to the time-separation data pairs, the intercept is equivalent to the electrical delay. As a check of the validity of the calibration, the inverse slope should equal the velocity of the standard.
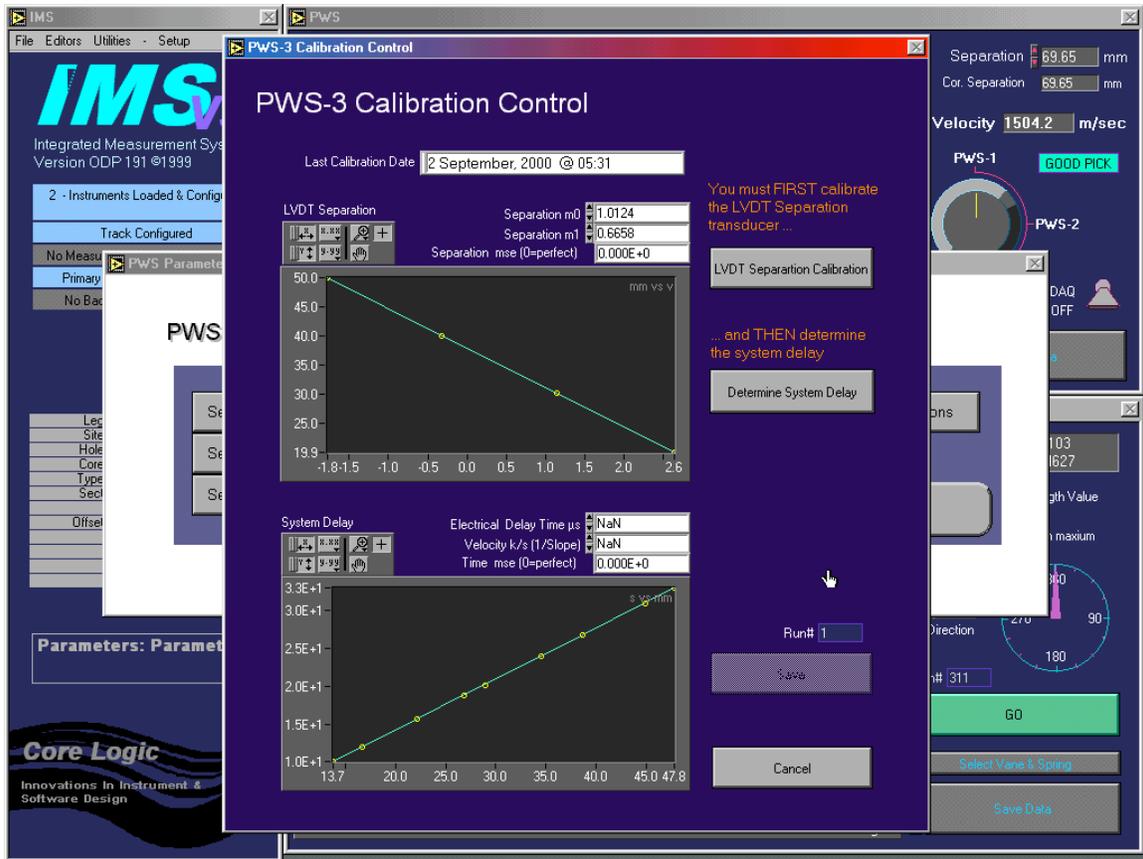
Figure 10. PWS3 Calibration Control.

Use the following instructions:

1.   From the main IMS VS screen, under SETUP select PARAMETERS and then PWS. Figure 8, the PWS Parameters screen, will appear. From this screen, select CALIBRATE PWS3 Calibration Control screen (Figure 10) will appear.

2. Click on LVDT SEPARATION CALIBRATION. This will bring up the LVDT calibration screen (Figure 11).
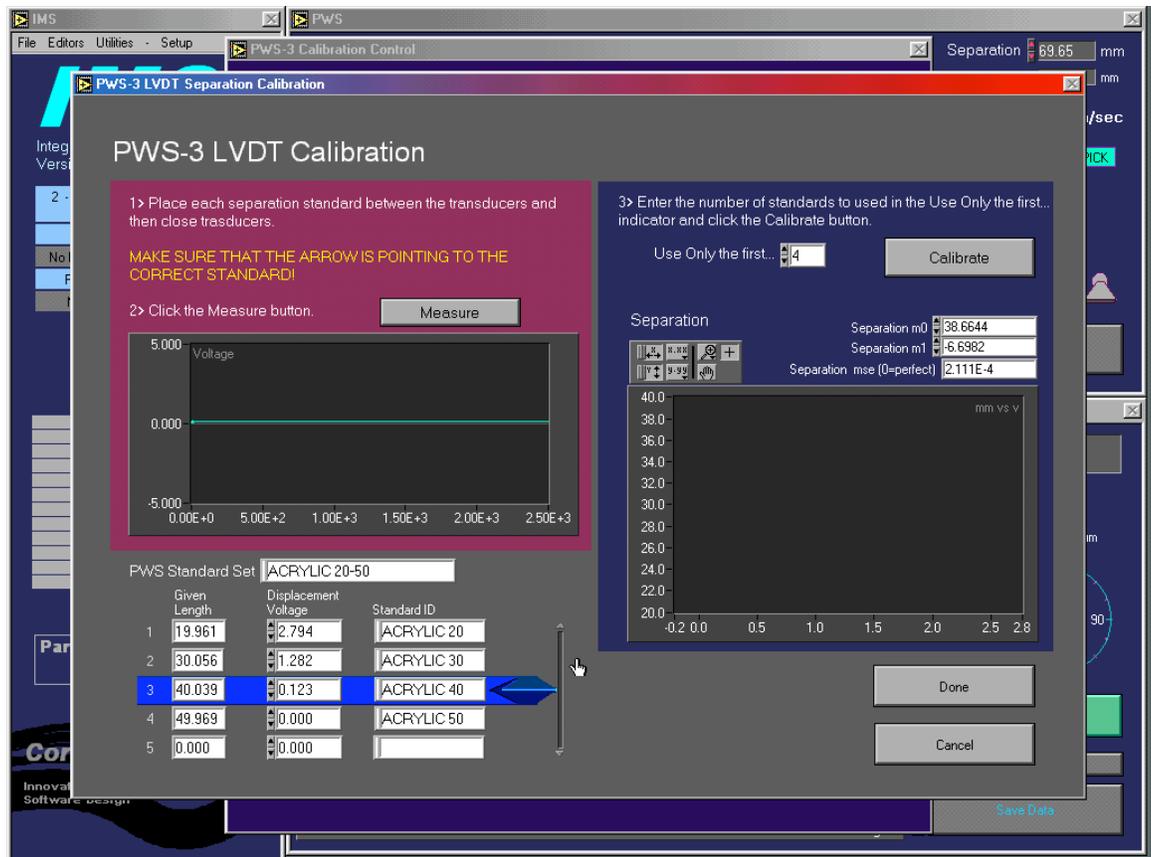
Figure 11. LVDT Separation Calibration.

1. Type in appropriate PWS Standard Set (usually ACRYLIC 20-50)
2. Wet the contact surfaces of each transducer with a bit of distilled water
3. Open the transducers and set the first standard on the lower transducer. Use calipers to double-check given lengths; enter the values in the correct column.
4. Screw the transducers together until they just contact the standard
5. With the blue arrow highlighting the correct standard, click MEASURE. A green horizontal line should appear in the left graph indicating voltage. The displacement voltage will fluctuate within a small range.
6. Click MEASURE again to set the value
7. Repeat Steps 4 through 8 with the remaining standards, being sure to set the blue arrow to the correct standard
8. Enter the number of standards you used in the "Use Only the first…" box
9. Click CALIBRATION and IMS VS will calculate the displacement and display the linear plot in the right graph
10. Click DONE to save this part of the calibration and to return to the PWS3 calibration screen. The plot and values should transfer to the main screen.
11. Next, click on DETERMINE SYSTEM DELAY to bring up the PWS Delay Calibration screen (Figure 12)
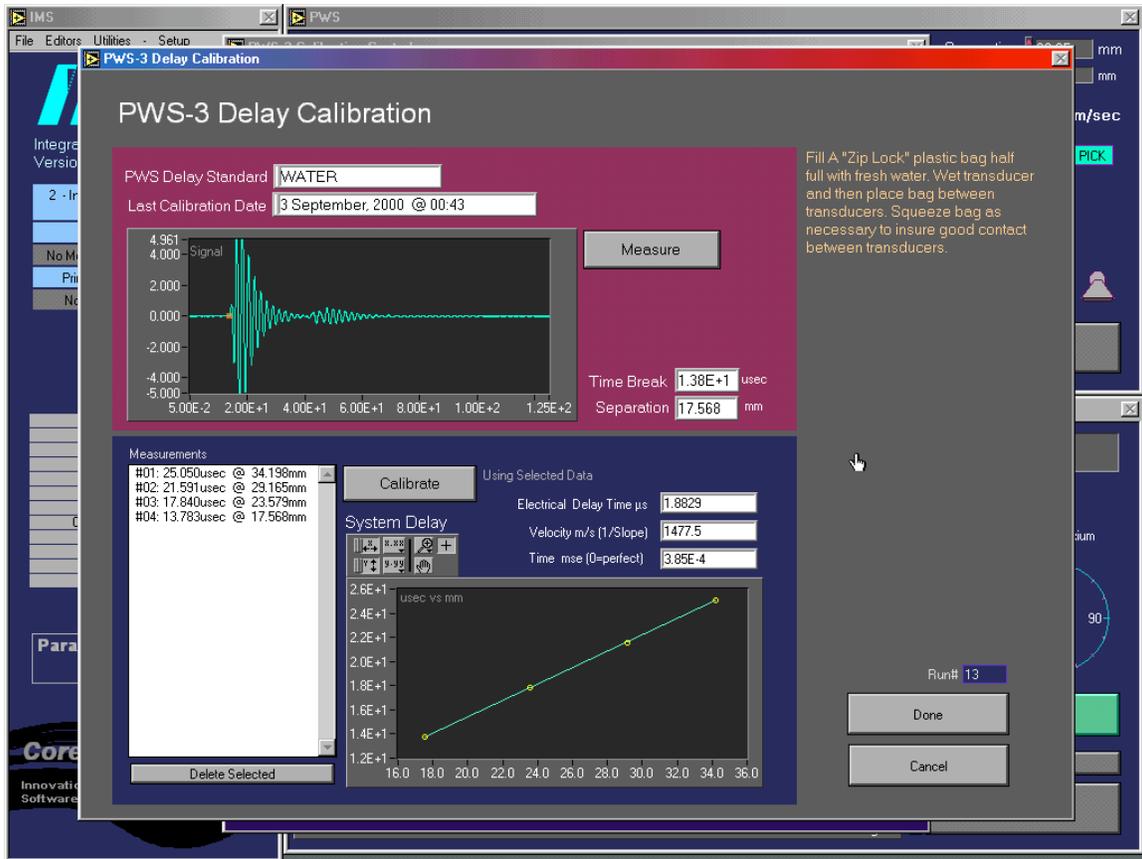
Figure 12. PWS3 Delay Calibration.

12. Delete any previous measurements by clicking on them to highlight and then clicking on DELETE SELECTED
13. Fill a Zip-Loc plastic bag half full with distilled water
14. Wet the transducers and place the bag on the lower one, squeezing the bag to put as much water between the transducers as possible
15. Click MEASURE and the signal will appear as a waveform in the upper graph
16. Click HALT to complete measurement and list data in the left column
17. Bring the transducers slightly closer together
18. Repeat Steps 17 through 19 until you have collected a series of measurements
19. Remove any data you do not want to include in the calibration calculates
20. Click CALIBRATE and IMS VS will calculate the electrical time delay and velocity. A linear progression should appear on the lower graph. Discard any points which do not fall on the line and click CALIBRATE again.
21. When you are satisfied with the graph, click DONE to return to the PWS3 calibration screen. The plot and values should transfer to the main screen.
22. Click SAVE to save the entire calibration file (this is a relatively slow process so be patient)

NOTE: SOMETIMES A DIALOGUE BOX WILL APPEAR STATING THAT THE WATER STANDARD HAS NOT BEEN DEFINED. CLICK **OK** AND THE FILE WILL UPDATE AUTOMATICALLY BEFORE THE CALIBRATION DATA IS SAVED.

3.9 AVS Spring and Vane Calibration Data

To access the AVS Parameters screen (Figure 13), under the SETUP menu on the main IMS VS panel select PARAMETERS and then VANE SHEAR.
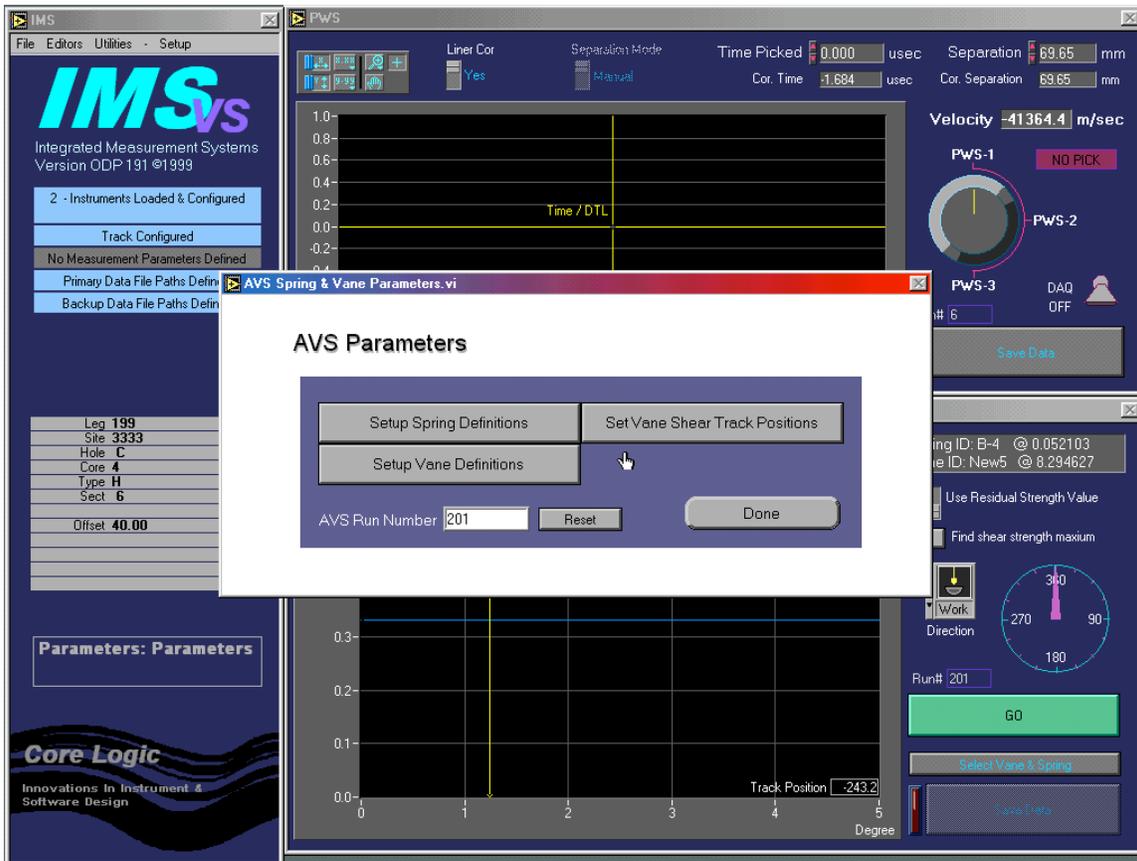
Figure 13. AVS Parameters.

The spring constants are calculated at the factory and shipped with the calibration sheets. These calibration data need to be entered and saved (one time only) for each spring used. This will be done by the Physical Properties technician. To enter a new spring, do the following:

1. Click SETUP SPRING DEFINITIONS to bring up the Spring List Editor screen (Figure 14)
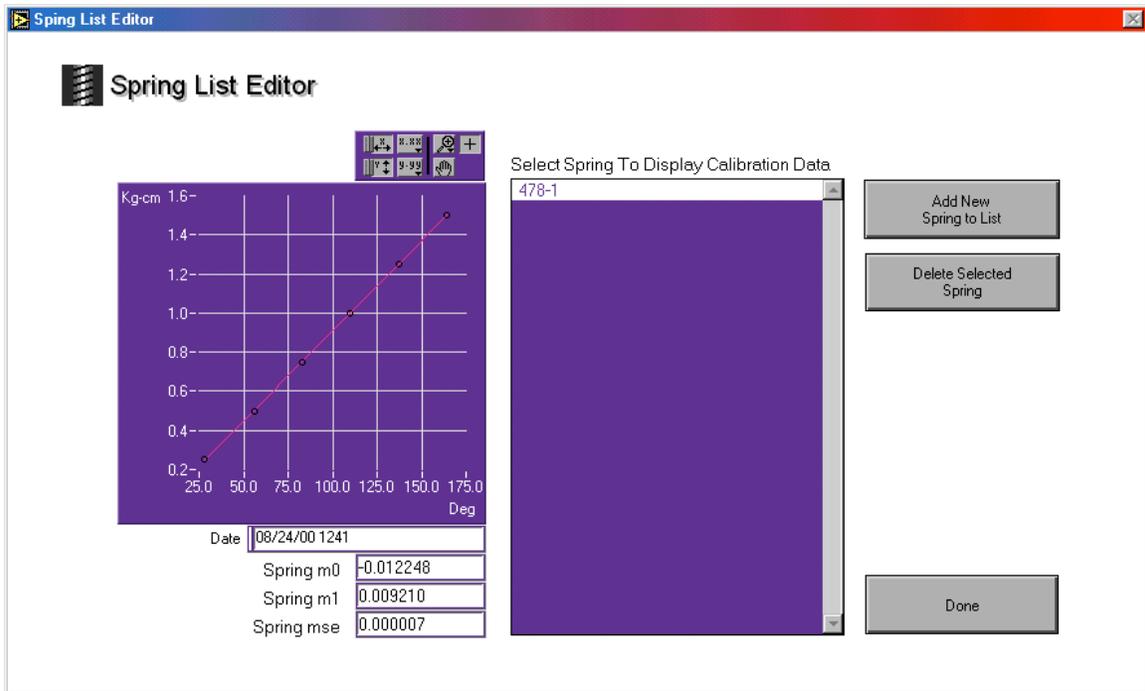
Figure 14. Spring List Editor.

2. Click ADD NEW SPRING TO LIST; You will be asked to enter the name of a spring (usually the serial number) and this will bring up the New Spring screen (Figure 15).
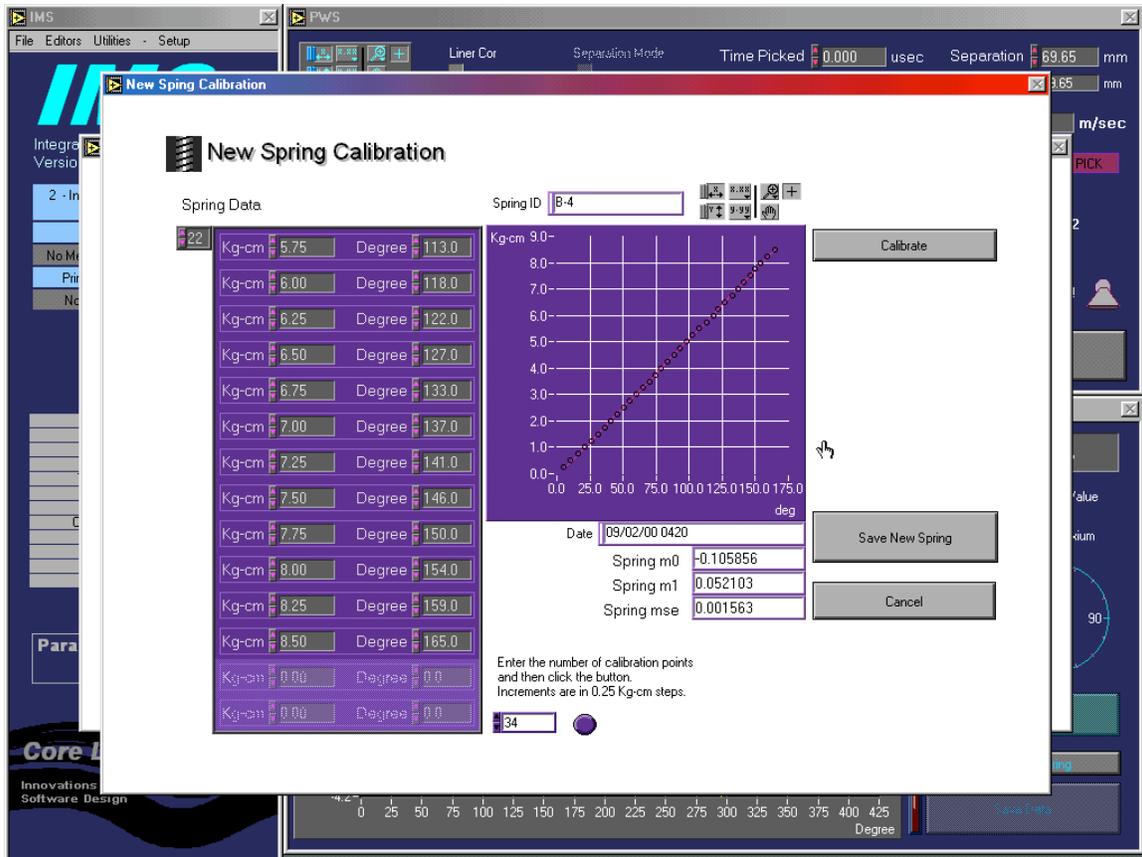
Figure 15. New Spring Calibration.

3. Enter the number of calibration points in the box at the bottom center of the screen, and then click the button to highlight pairs
4. Enter the spring's Kg-cm and degree of rotation data pairs in the left columns. To add more pairs, click on the small box in the upper left corner to increase the number.
5. When all pairs have been entered, click CALIBRATE to see the linear graph
6. Click SAVE NEW SPRING to save data and return to the Spring List Editor Screen
7. Repeat steps 2 through 6 for each spring
8. Click DONE to return to the AVS Parameters screen

The vane constants are based on the height and width of the vane blades. This calibration data needs to e entered and saved for each vane used but only once. This will be done by the Physical Properties technician. To enter a new spring, do the following:

1. Click SETUP VANE DEFINITIONS to bring up the Spring List Editor screen (Figure 16)
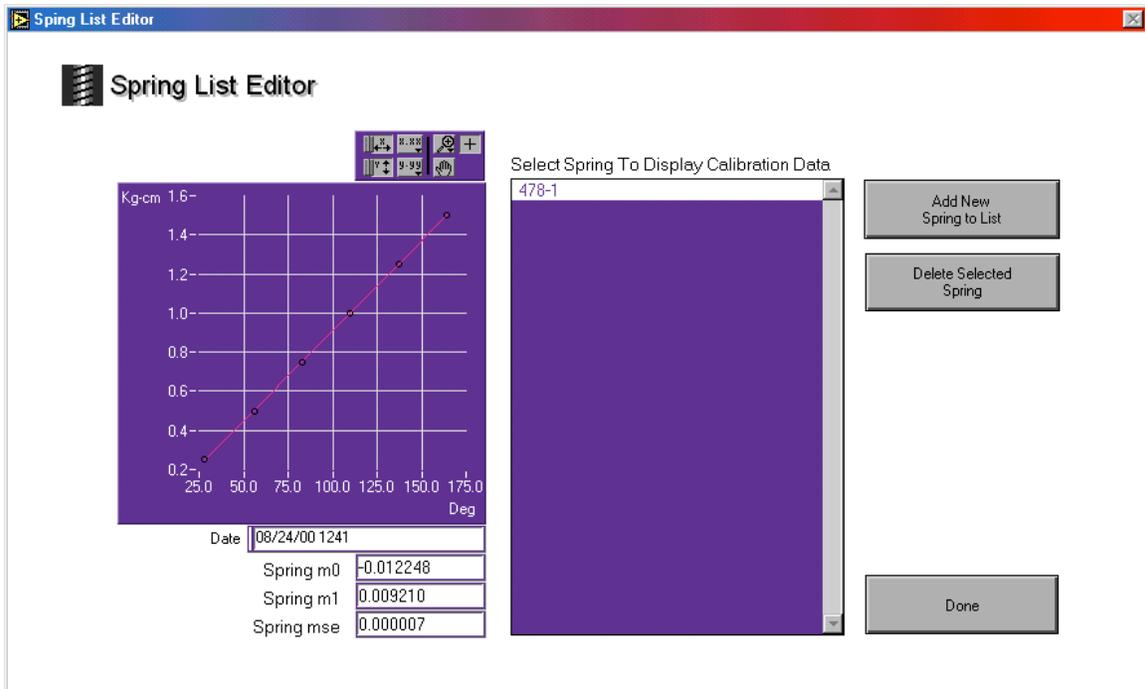
Figure 16. Spring List Editor

2. Click ADD NEW SPRING TO LIST
3. You will be asked to enter the name of the new vane (usually the colour) and this will bring up the New Vane Calculator screen (Figure 17)
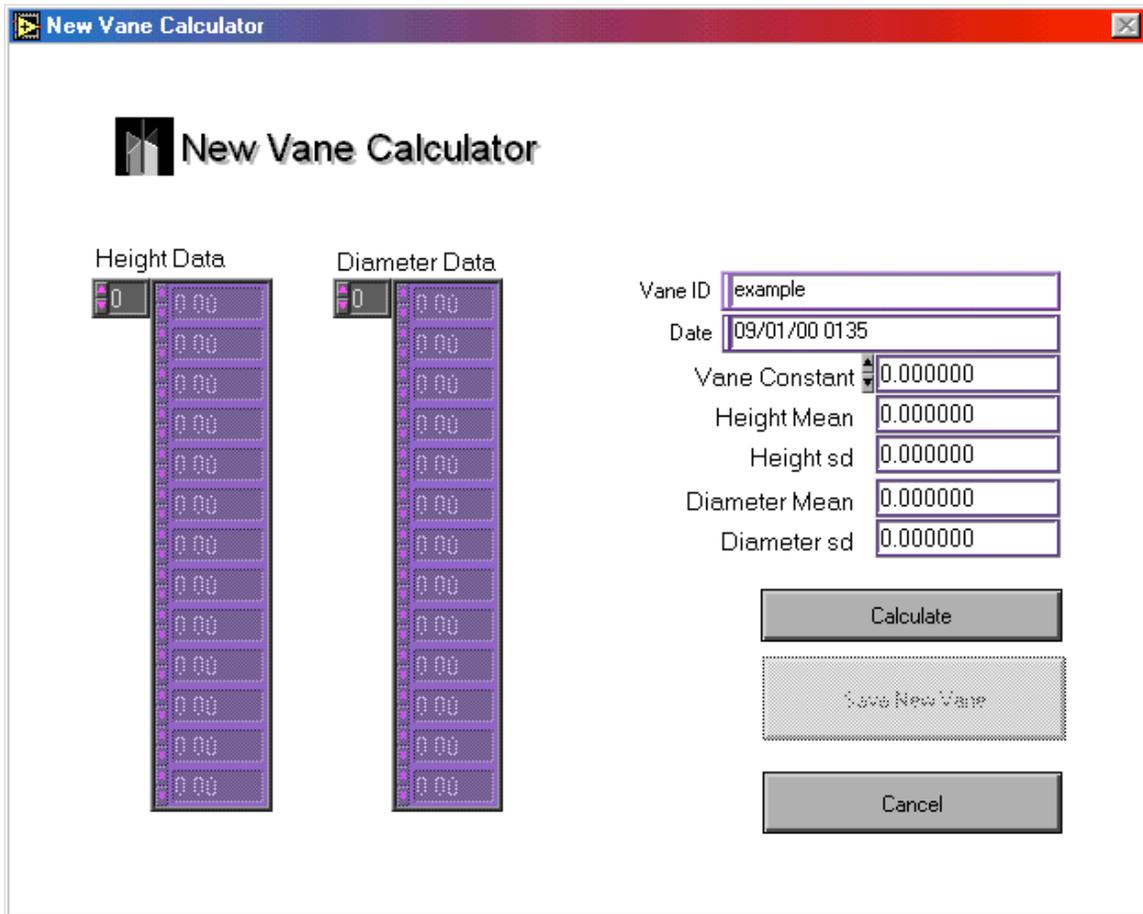
Figure 17. New Vane Calculator.

4. If you have the data, enter the vane's height and width data pairs in the left columns. Click CALCULATE and the SAVE NEW VANE. Often the vane will arrive with only the vane constant; should this be the case, click CALCULATE and then enter the vane constant manually. If do not click CALCULATE first, the SAVE NEW VANE button will remain grayed out. Once the constant has been entered, click SAVE NEW VANE.
5. Repeat steps 2 through 4 for each vane
6. Click DONE to close panel and return to the AVS PARAMETERS screen

4.   Routine Measurements

4.1. Starting a measurement

Record ALL relevant information on the paper logsheets assigned to each station. It may seem redundant but it may possibly save a lot of headaches later!

All leg, site, hole, core, core type, and core section information will be edited on the SAVE DATA screen when you are ready to save the measurements.

Hook the clip of the shuttle to the blue end cap of the section and position the section under the PWS or AVS station you wish to measure (track position indicators are in the lower right corner of each graph).

4.2 PWS1 & 2 Measurement

Use the following instructions:

1. Measurements will be made using the upper right graph. Turn the knob so that the yellow indicator line is pointing to either PWS1 or PWS2, whichever you intend to measure.
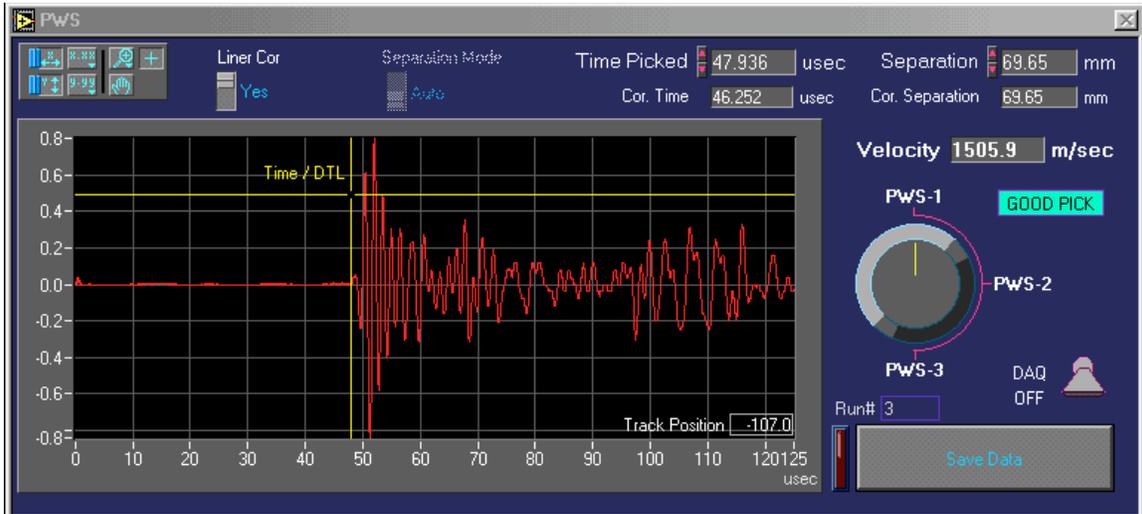
<mark>Figure 18. PWS screen.</mark>

2. Use the air valve to lower the transducers into the sediment where you would like the measurement to be taken. Toggle DAQ to ON and a waveform will appear on the screen.
3. Insert the thermocouple probe into the sediment close to the transducers, but not between the transducer blades. The temperature will appear on the digital box above the track. This number must be entered manually into the correct box on the Save Data screen once the measurement has been completed.
4. Ensure the liner correction toggle is set to YES (it will default to NO when the program is started)
5. Check the separation (PWS1 = 69.65; PWS2 = 34.85)
6. Toggle DAQ to OFF to set the first pick of arrival time

The computer will pick the first arrival time and calculate the delay time. Alternatively, you can manually pick the first arrival time by dragging the vertical yellow cursor to the appropriate position. The computer will then recalculate the delay time with this new value.

7. Click SAVE DATA to bring up the Save Data screen <mark>(Figure 21)</mark>.
8. See section <mark>4.1 Saving Data</mark> for information on this screen

4.3 PWS3 Measurements

1. Measurements will be made using the upper right graph <mark>(Figure 18)</mark>. Turn the knob so that the yellow indicator line is pointing to PWS 3.
2. For **half cores**: Wet both transducers and slide half core with shuttle under PWS 3 to where the measurement will be taken.
3. Lower trasnducer so that the top transducer is in contact with the sediment Toggle DAQ to ON and a waveform will appear on the screen.
4. Ensure liner correction is toggled to YES and Separation Mode is on AUTO.
5. Remember to keep lower transducer in down position.

The Computer will pick the first arrival time and calculate the delay time. You can manually pick the first arrival time by dragging the vertical yellow cursor to the appropriate position. Th computer will then recalculate the delay time with this new value. Click DAQ to OFF.

6. Click SAVE DATA to bring up the Save Data screen (Figure 21). See Section on saving data.
7. For **minicores and cubes**: Wet both transducers then lower down until they are in contact with the sample. Wetting the transducers allow for better contact between the core and transducers giving more accurate readings.
8. Click Liner Correction to NO, Separation Mode to AUTO, and then click the DAQ to on.
9. A waveform will appear on the screen and the computer will select the first arrival time unless you wish to choose a different one. Click DAQ to OFF.
10. Click SAVE DATA and make sure to enter the correct interval from which the sample was taken.

4.3 <u>Shear Vane Measurements</u>

1. Measurements will be made usingin the lower right graph.
2. Lower AVS into the sediment using the air valve and make sure the sediment does not crack.
2. Once the correct vane and spring ar4e selected click GO to begin the AVS measurement.

4.5 <u>Saving Data</u>

When you are satisfied with the waveform and velocity pick, click SAVE DATA to write the file. Double check the current leg, site, and hole identifiers, the position, and enter the correct core, core type, and section on the Save Data screen (Figure 21). Click MEASURE TEMPERATURE or enter temperature manually. If you wish to save the waveform data, make sure that the SAVE WAVEFORM control is set to YES before clicking SAVE. For PWS3, select the correct direction. If you are measuring minicores or cubes with PWS3, toggle Position Input to User Input; another box will appear in the bottom right of the screen where you may enter the correct interval manually.

> DO **NOT** RESET RUN NUMBERS AS ALL FILES ARE SAVED BY RUN NUMBER AND WILL OVERWRITE PREVIOUSLY WRITTEN FILES.

When all is in order, click SAVE.

Figure 21. Saving data.