

# Modal Acquisition using Cougar/PUMA

This tutorial is to help walk you through the process of acquiring data for a Modal Analysis test.

First, double click on the PUMA icon on your desktop, log-in, and then click in the PUMA splash screen as it appears. Once, the PUMA Local window (as shown in Figure 1) appears along with the Spectral Dynamics Viewer. Also, make sure that the PUMA DSP Server is running in the system tray as shown below.



We will want to open a profile that has already been created for you by Spectral Dynamics. Using the PUMA Local window, click the File/Open menu, and go to the C:\Program Files\Spectral Dynamics\Puma\RCTs directory and change the List of Files to \*.ACF and then double click on ANRCT2.ACF.

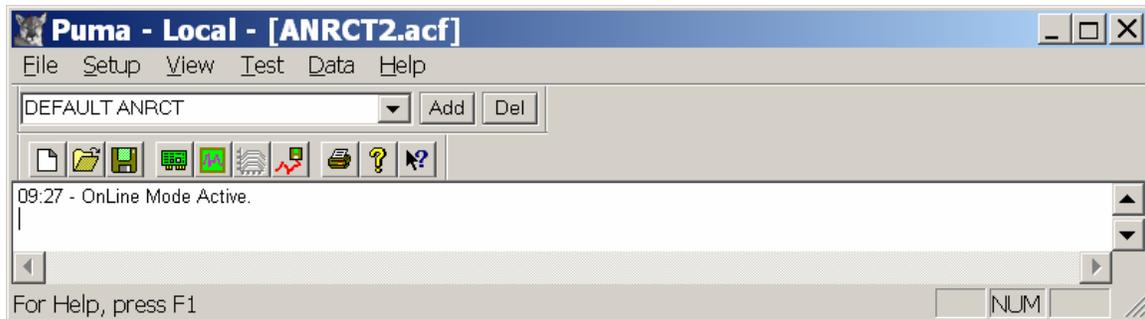


Figure 1

In the PUMA Local window as shown in Figure 1, click on Setup and then Acquisition.

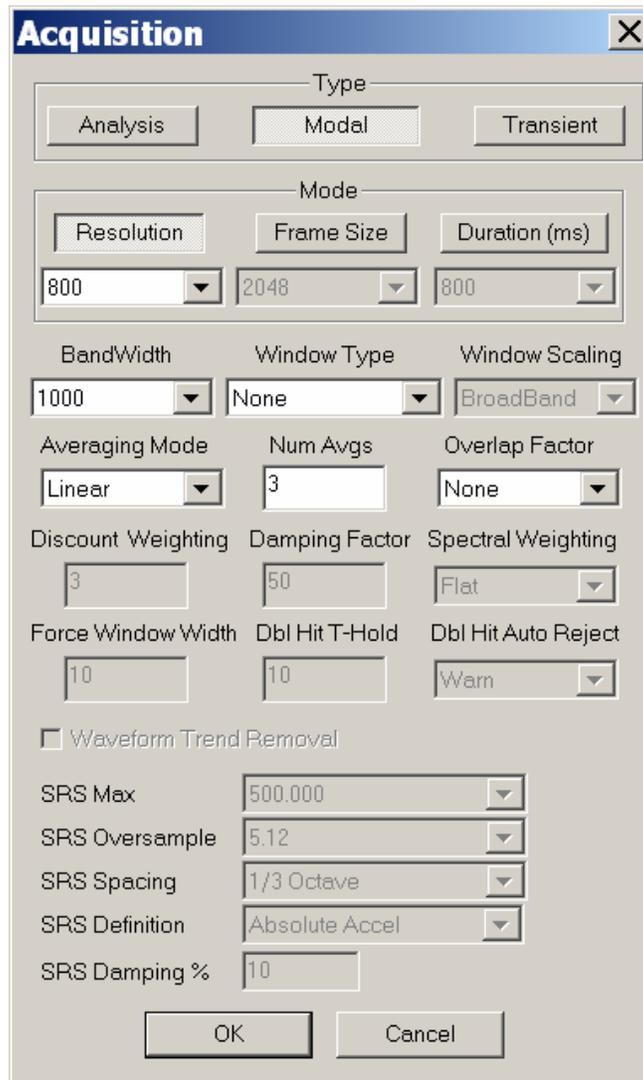


Figure 2

In Figure 2, we are going to setup the Acquisition panel for a Modal test. First, in the Type group, we need to select Modal. In the Mode group choose from either the Resolution or Frame size to specify the number of resolution lines within the measurement or the number of samples in the frame ie... (a frame size of 2048 samples results in 800 lines of resolution.  $2048/2.56 = 800$  lines). Set the

Resolution to 800 lines, Bandwidth to 1000Hz, Window Type set to None, set the Averaging Mode to Linear and Number of Averages to 3.

Once, you have setup the Acquisition Panel, then Click OK.

**Notes:** Every structure is different and therefore, the settings for Resolution, Bandwidth, Window type, type of Averaging and number of averages may be different for your situation.

A Modal survey of the structure is usually a good idea. This will help you to identify the frequency range of interest and to also select the best location to excite the structure (selection of the driving point).

Next, we will setup up the Channel table. So, go to the PUMA Local window and click Setup and then Channels.

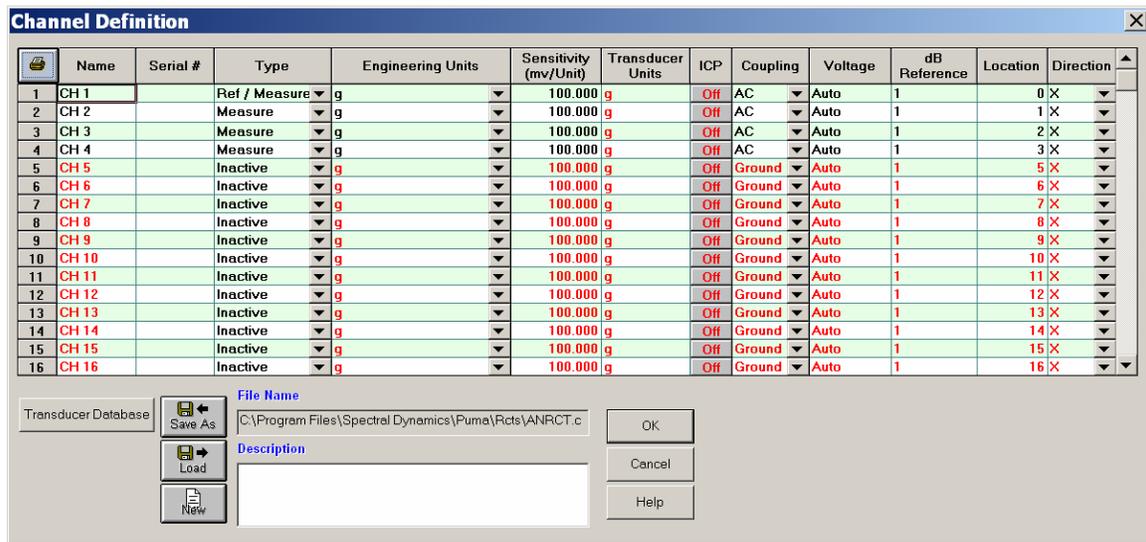


Figure 3

In the Names column, we just use this to identify the channel numbers, this is an editable field and you can edit these values, if you wish.

The Serial number column, can be used to record the accelerometer serial number. This field may be left blank.

The Type column, identifies the Type of Channel to be used ie... **Ref/Measure** selects a channel as the reference for which all cross measurements will be referenced. **Measure** refers to a Response channel, which is associated with the individual accelerometers. Then, there is **Inactive** which indicates that a channel is not being used.

Engineering Units allows the user to specify the units to be applied to a particular channel. To make additions to the drop down list box go back to the PUMA Local window, Setup menu, and choose Define Engineering Units and fill in the appropriate fields.

Sensitivity column is used to specify the sensitivity of the accelerometer.

Transducer Units identify the units of the transducer.

ICP turns enables or disables a 4ma constant current source capable of powering your accelerometers and hammer. In this experiment, I am using a hammer powered by the internal ICP supply and then a tri-axial accelerometer powered by an external power supply. So, click the ICP Off button for Channel 1 as shown in Figure 4.

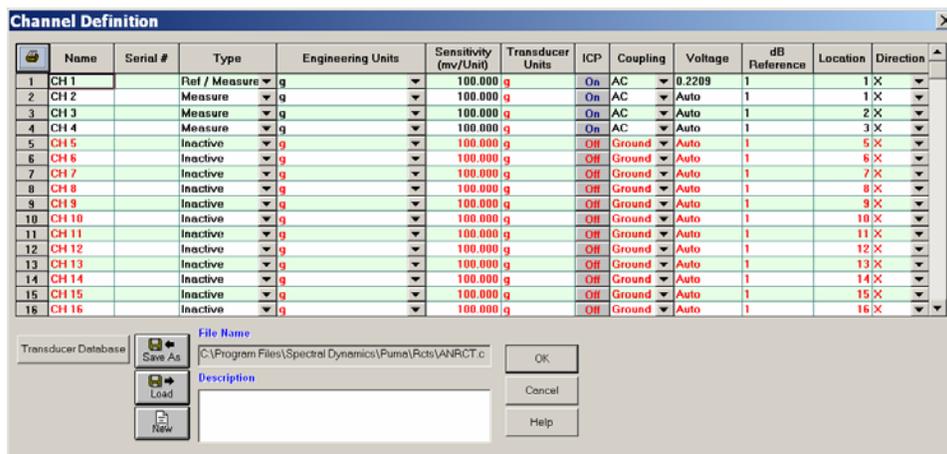


Figure 4

Coupling allows you to choose either AC or DC.

Voltage is the voltage range for each individual channel. The Default set to Auto, but, you can manually edit this field.

dB Reference leave this set to 1.

Location, allows you specify the models point number to be measured.

Direction, allows you specify the orientation of the accelerometer. The selections to choose from are X,Y,Z or -X,-Y,-Z. For those who require R,T, or P, just use the X,Y,or Z and then we can edit the directions once, we get them into STAR/CATSModal.

Click OK when your done.

Now, we need to setup the Data Storage. This allows us to select various measurement types, a file naming scheme and to select a storage format that our software understands.

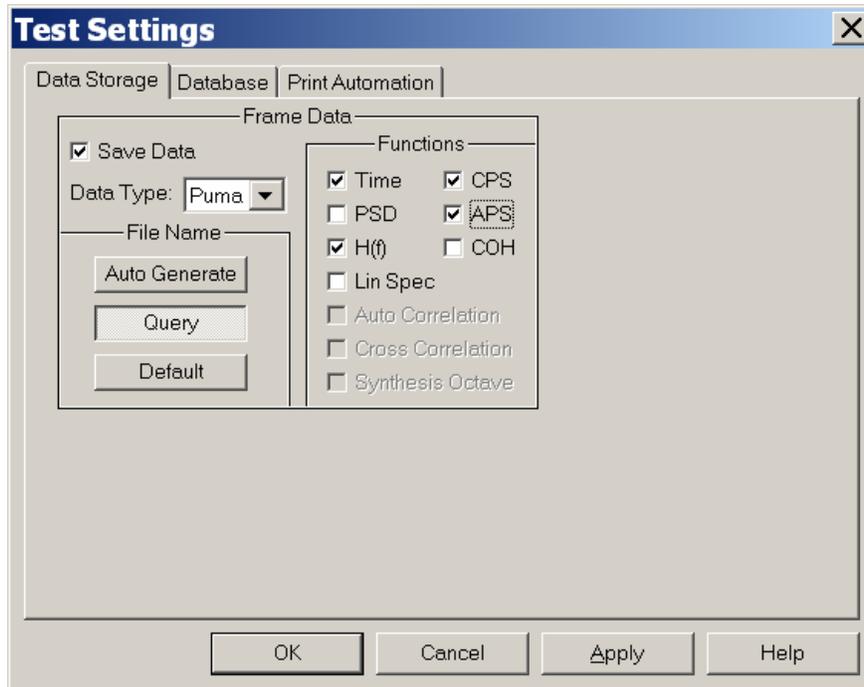


Figure 5

Go to the PUMA Local window choose Setup, and then Control. In Figure 5, make sure that the Save Data check box is checked.

Select PUMA as the data storage format. The PUMA format has a SDD extension and is the file format that STAR/CATSModal uses. The Universal File Format (UFF) is an alternate file storage format.

Choose the Query for the File Naming scheme. This allows you to specify the filename and directory where the file is to be stored. When prompted, create a filename that is the same name as the Modal project. By doing this the SDD file will be opened automatically when opening the STAR/CATSModal project.

From the list of Functions choose, H(f) (this is a minimum for doing Modal Analysis), CPSs and APSs, if you are interested in doing (ODS) Operating Deflection Shapes and Time if your doing (TDA) Time Domain Analysis.

Click Apply and then OK when you are done.

Next, let's setup the Analyzer Control panel shown in Figure 6.

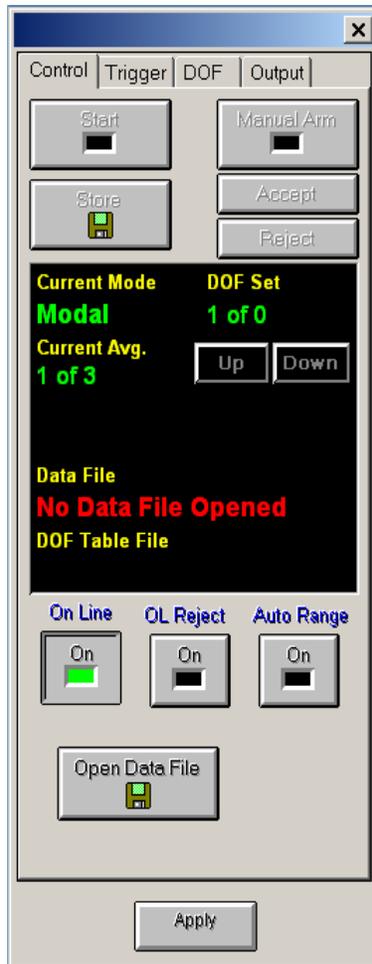


Figure 6

Click on the DOF tab as shown in Figure 7.

Response DOF Processing has three choices:

- 1) None: Uses the Location and Directions values in the Channel Table. In this configuration the point and directions are edited manually by the User for each acquisition.
- 2) Auto: This setting uses the Auto Increment group selections below. This selection automatically manages the measurement point and direction information. This is the easiest choice, if you are taking data in a sequential manner ie.. 1, 2, to 3 and so on.
- 3) Table: If you are taking data in a non-sequential manner then creating individual tables to automatically assign points and directions is very helpful. Set it and forget it.

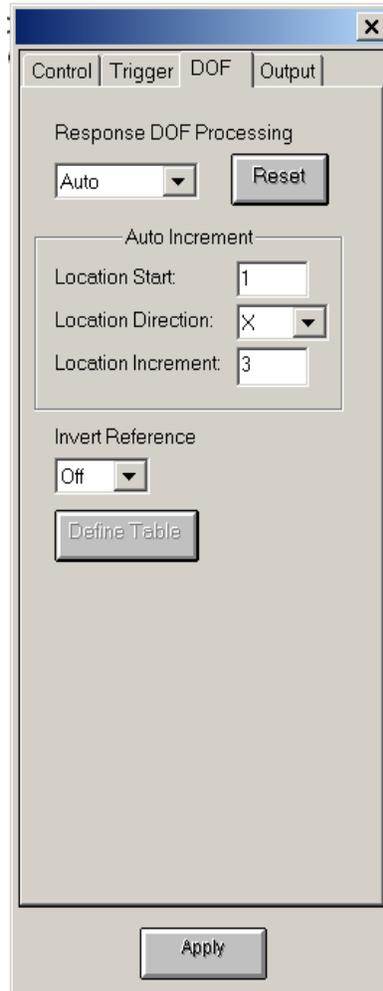


Figure 7

The Reset button, resets the Auto Increment settings back to the default setup.

Now, click the Trigger tab, and let's setup the Triggering.

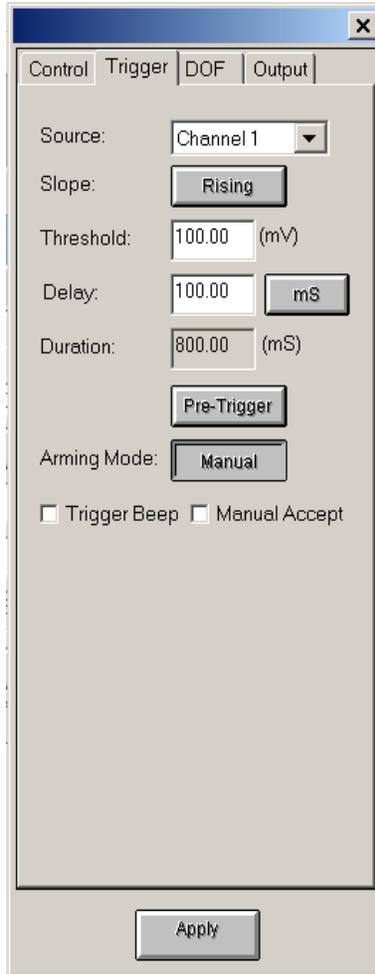


Figure 8

Choose the Source or Trigger channel, there will be a trigger selection for every channel in your system, plus Free Run and External (External Trigger input is on the rear panel of your PUMA or Cougar).

Set the Trigger Slope either Rising or Falling.

Set the Trigger Threshold in mv's.

Set the Trigger Delay in milliseconds.

Click the Pre-Trigger or Post Trigger button. The Trigger delay is applied either before the trigger event or after.

Set the Trigger Arming to Automatic or Manual. This allows you to Arm the Trigger either manually or automatically.

Check or Uncheck Manual Accept. You can manually accept or reject each and every trigger event. This allows you to make sure that only high quality data is included in the averaging process.

Once, the Trigger settings are configured click the Apply button.

Click the Control tab as shown in Figure 9.

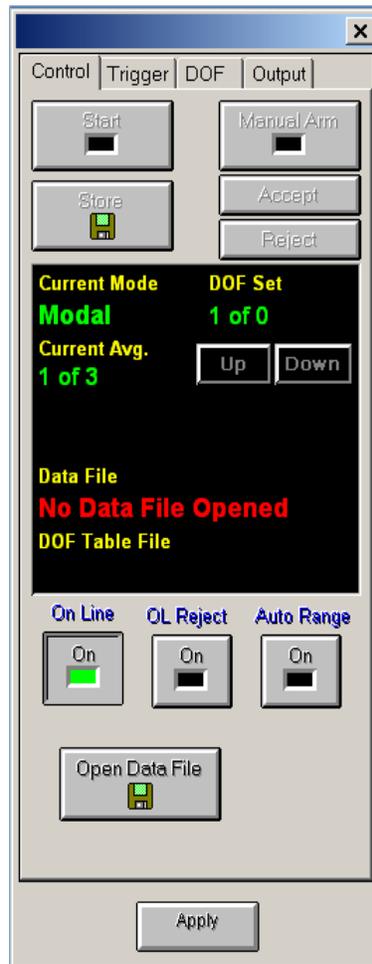


Figure 9

Next, we need to modify the individual plots in the Spectral Dynamics Viewer, to display the measurements we are actually interested in. For this discussion, I will call the upper left Plot as Plot 1, upper right as Plot 2, lower left Plot 3 and finally lower right as Plot 4.

Left click on any of the plots in the Spectral Dynamics Viewer and this will become the Active Plot as shown in Figure 10, depicted by black border around the plot. Then, if you right click anywhere in the Active Plot, a menu will appear

with a variety of plot and graph parameters that allow you to customize your plots.

Additional menus are accessible to control the X and Y axes parameters. If you right click between the X and Y scale values and the graph plot borders they will appear. Here, you can control the Grids and Tics and also set the scaling to be either Log or Linear.

In the upper left corner of each plot is the Plot Definition label. This label specifies the measurement that is being displayed. If you right click on the Plot Definition label, a menu will appear that allows you to change the Channel, Reference Channel and Function. There are other selections in the menu that are available not listed here.

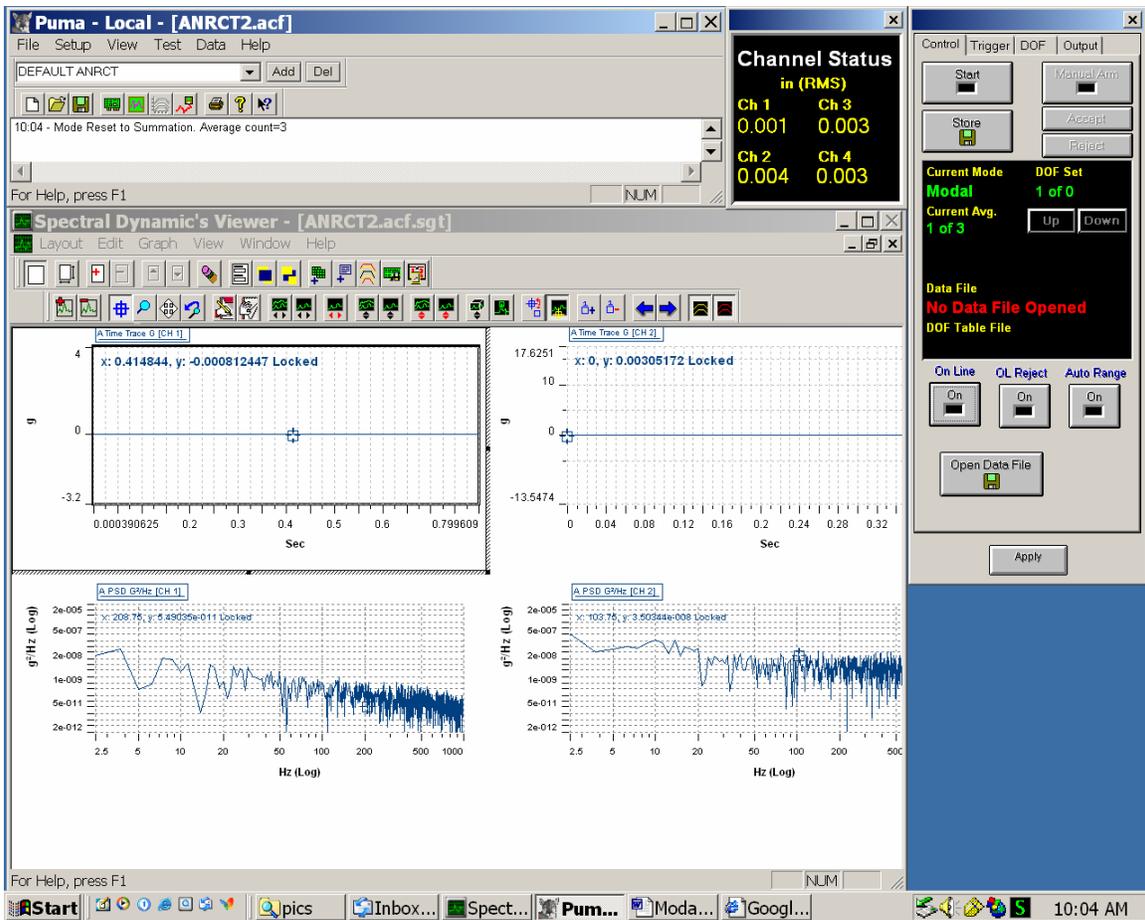


Figure 10

The signal analysis s/w's defaults to having the reference channels set to none. Since, this is the case all the Measurement types listed in the Function Menu are single channel measurements such as Time, PSD, Magnitude Spectrum, and Linear Spectrum.

In order to enable the cross channel measurements, such as Frequency Response Function, Cross Spectra, and Coherence we, need to turn on a Reference Channel and set it to Channel 1.

An alternate way to control the type of measurements that are displayed in each of the plots is through the Plot Definition toolbar. This can be activated by selecting the View menu on the Spectral Dynamics Viewer as shown in Figure 11.



Figure 11

In Figure 11, to get the cross channel measurements, click the Ref Channel drop down list box and select Channel 1 as the Reference. Once, the Reference is selected, the cross measurement types will be display in the upper right hand drop down list box.

One possible arrangement of plots would be for Plot 1 to display a Time trace of Channel 1 to display our hammer impacts, Plot 2, 3 and 4 will display a H(f) Magnitude, of channel pairs 2/1, 3/1 and 4/1, respectively.

Once, the plots are all set up to display the functions you want to see. We need to set the individual channel Voltage ranges. Refer back to Figure 10, the Control tab on the Analyzer Control dialog and click the On Line button so, that the Green light is illuminated. Then, go to the Trigger tab and change the Source to Free Run. In Figure 12, the Channel Status monitors the levels that are seen on Channels 1 through 4. There are three states, yellow, green and red. The yellow indicates an under voltage, green indicates within range and red indicates an over voltage condition. So, when we are using a hammer to impact our structure, the ideal situation is for all channels to be green. Sometimes, it's not always possible but, you need to make the decision in this case. Never, never, accept an average, if any of the channels has been overloaded.

One way to help in this is to enable the Manual Accept checkbox on the Triggering tab. This will allow you to individually Accept or Reject any acquisition. If conditions such as an under voltage, double hits or a channel overload then reject it.

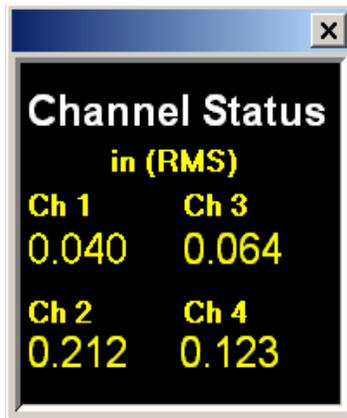


Figure 12

Attach the accelerometers to the structure.

I would also suggest that we create another page of plots to give us an idea how the voltage range should be set.



Figure 13

If the toolbar shown in Figure 13, is not visible in the Spectral Dynamics Viewer then, click the View menu in the Spectral Dynamics Viewer and click Page Settings.

Click the icon with the Red Plus. This will add an additional page, where plots can be added.

Now, click the Black Up arrow. This will move you to a blank page. Next, we need to add plots to this page. So, click on the third icon from the Right (set number of Rows and Columns). Set the Rows and Columns each to 2 as shown in Figure 14.

The dialog box titled "Enter Number Rows and Columns" has the following fields and buttons:

- Rows:
- Columns:
- Buttons: OK, Cancel

Figure 14

Click OK and four plots will be added to the page. Next, refer back to the Plot Definition toolbar as shown in Figure 11. Left click on Plot 1, to make it the Active Plot, then using the Plot Definition toolbar, select Time function and Units equal to g's. Then repeat the process, by clicking on Plots 2, 3 and 4, set each plot function to Time and the units to g's.

Next, tap the structure a number of times. If the toolbar shown in Figure 15 is not displayed, click on the Spectral Dynamics Viewer, View menu and then click the Plot toolbar.

On the Plot toolbar, as shown below are the X and Y Auto Scale button. The black right and left arrowed icons auto scale the X axis. The black up and down arrows auto scale the Y axis.



Figure 15

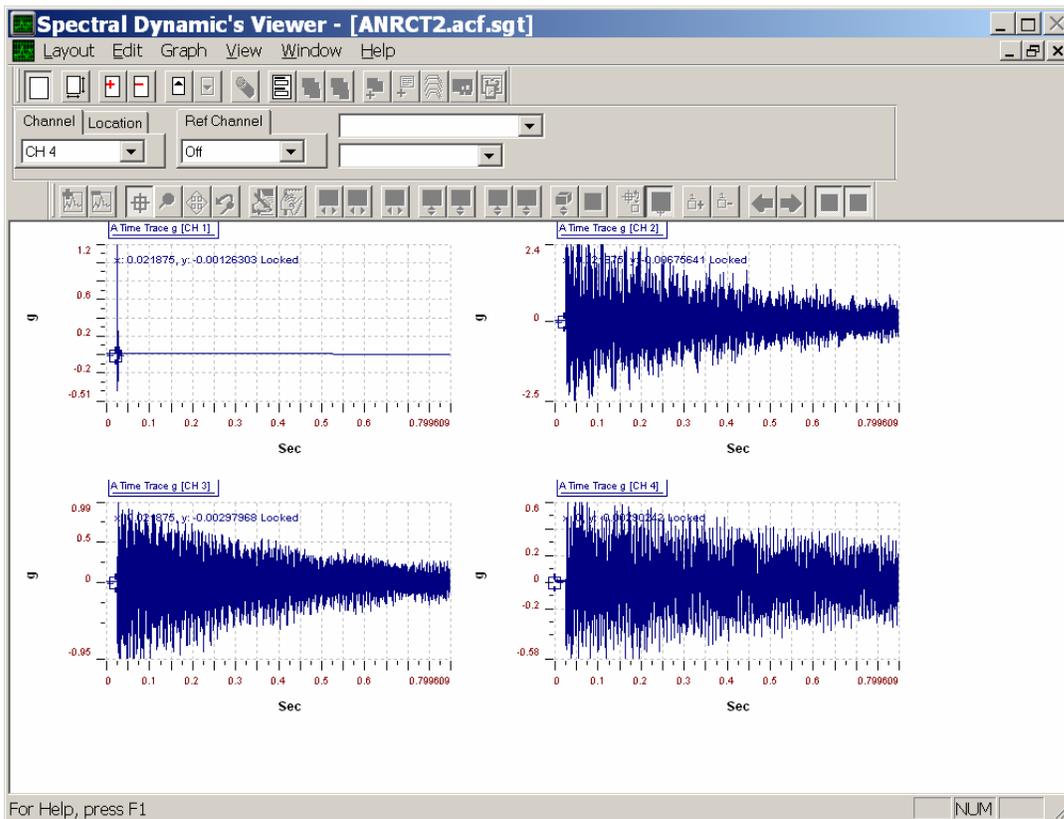


Figure 16

Once, you've tapped the structure and auto ranged the Y Scale so, that each of the enter spectra is visible as shown in Figure 16. Look at the positive Y scale range on each plot, multiply that by the accelerometer sensitivity and then add 100mv to come up with a voltage range for each channel. Enter these values in the Channel Table.

Now, tap the structure again, and make sure that the Channel Status indicators (shown in Figure 12) are all in the green. I would also suggest moving the accelerometers to a different location on the structure and tap again, make sure that the Channel Status is still reporting an all green condition.

If any of the Channel Status indicators show up as Red then that particular Channels voltage range needs to be increased. The channel overload could have been because the hammer impact was to strong. Try again, this time using less force, if the channel is still Red then adjust the Channel Table Voltage values. If it is now Green, your fine.

We are now, all set to begin the data acquisition process!

On the Analyzer Control panel as shown in Figure 17, go to the Trigger tab and set the Triggering Source to Channel 1, return to the Control tab, click on the On Line button to turn off the On Line mode, the button will turn from green to black. And lastly, click on the Start button to begin the acquisition.

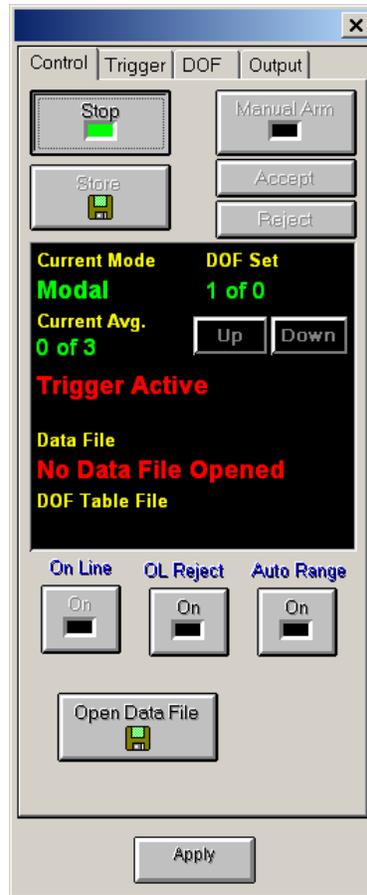


Figure 17

As shown in Figure 17, Current Average is 0 of 3, the Trigger is Active, (waiting for an impact), and there is no Data File open for storage.

Now, tap the structure and the following will happen,

1) If the impact was of sufficient force to cause the system to Trigger, and if Manual Accept is set on the Trigger tab, the Accept/Reject buttons will turn from gray to black. Check the Channel Status and make sure that all the channels are Green and none of the channels are overloaded (Red). Also, look at Plot 1, and make sure that you did not get a double hit. At this point, you can either choose to Accept or Reject the average. Once, you've the clicked Accept button, repeat these steps until the averaging process is complete (current average is 3 of 3) as shown in Figure 18.

2) Once, the averaging process for this acquisition process is complete, the Store button will be enabled, Click it. In the Data Storage setup we had previously, set the File Name to Query, you will be prompted for a file name and where the measurements are to be stored. The default

extension for this file is SDD (Spectral Dynamics Data Format). The file name should be the same name as the STAR/CATSModal project that you've created. Also, this file needs to be stored in the same STAR/CATSModal project directory.

3) Repeat steps 1 and 2 until you have taken all the data at all points on your structure.

4) When you have taken your last measurement and clicked the Store button, and then you will need to close the data file. So, click the Close button

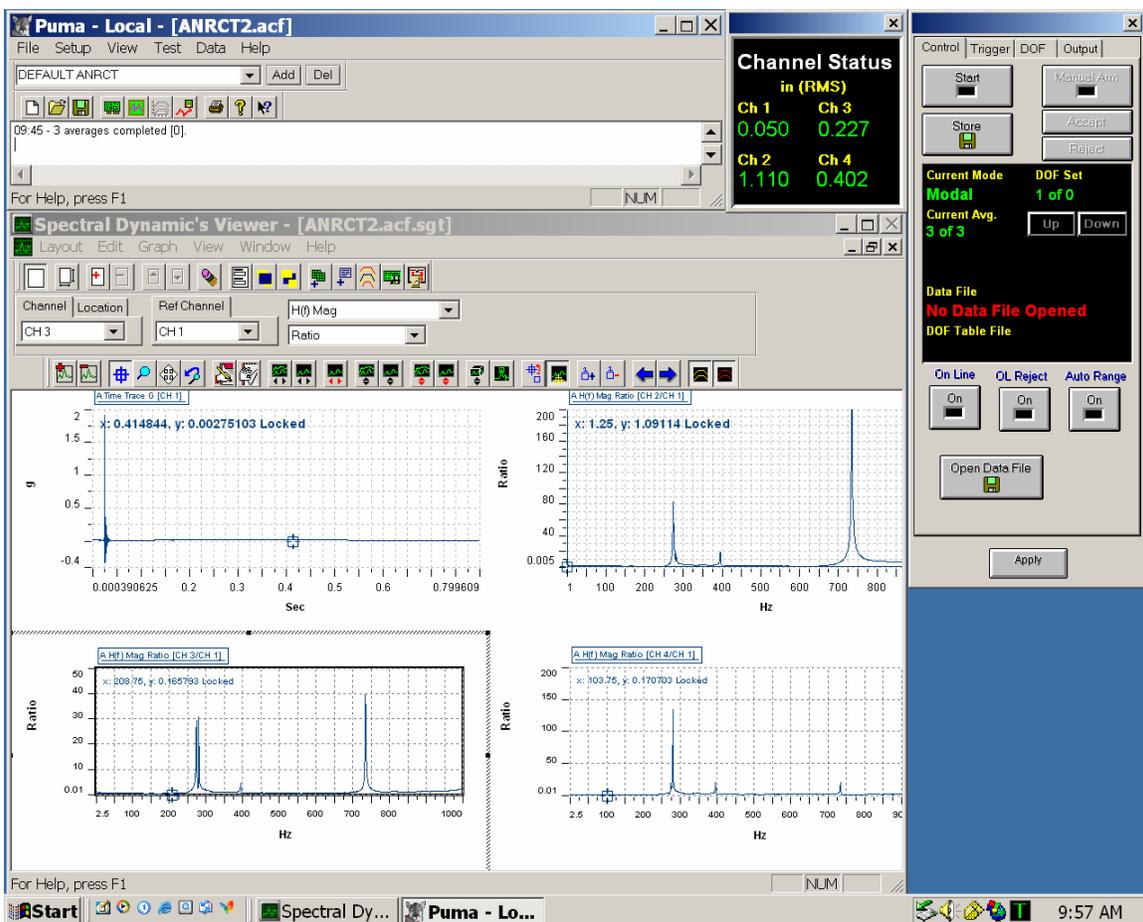


Figure 18