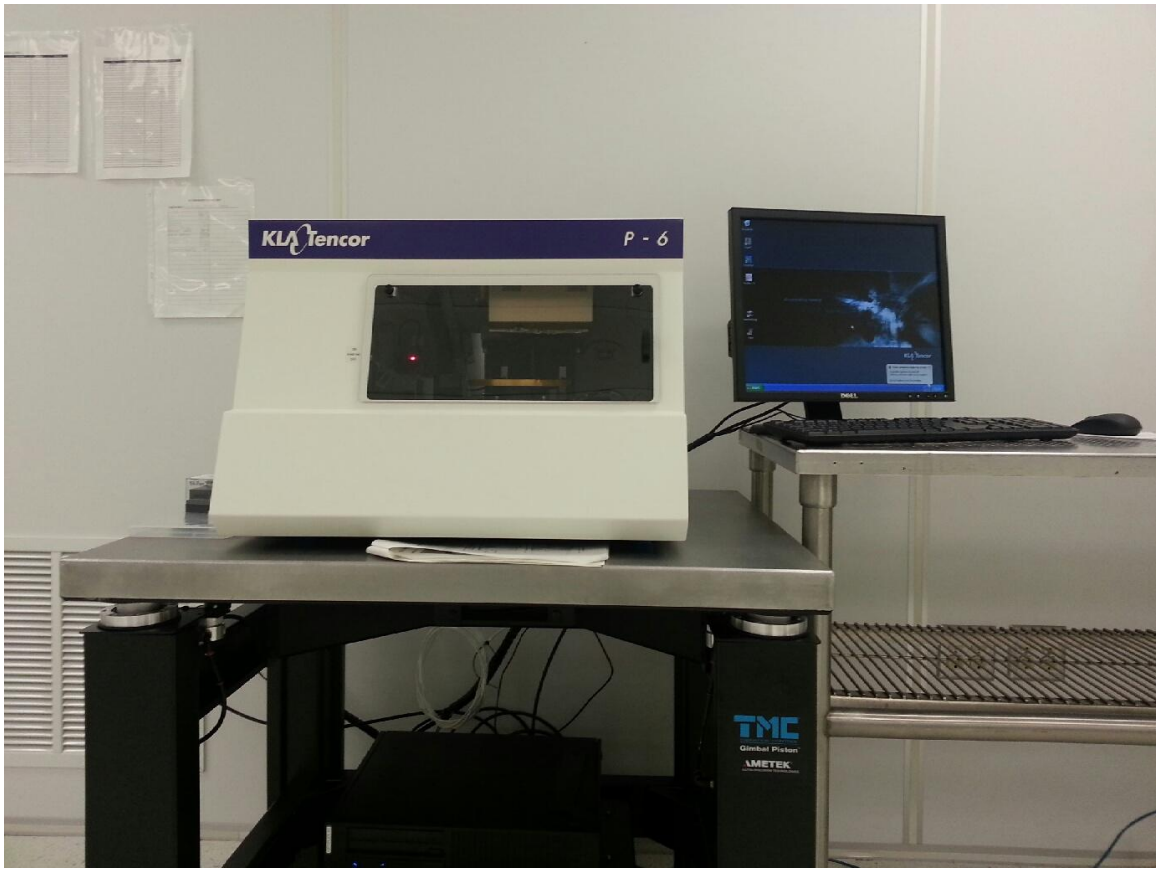
KLA Tencor P6 Profilometer Standard Operating Procedure

Version: 1.0 **Oct. 2012**



UNIVERSITY OF TEXAS AT ARLINGTON

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1 INTRODUCTION

1.1 Scope

These procedures apply to the KLA Tencor P6 Profilometer. All maintenance should follow the procedures set forth in the manufacturer's maintenance and operations manuals. This document is for reference only. Personnel should be trained by authorized staff before operating this equipment.

1.2 Description

The KLA-Tencor P-6 Profiler is a highly sensitive surface profiler that measures step height, roughness, and waviness on sample surfaces. The KLA-Tencor P-6 Profiler system uses stylus-based scanning to achieve high resolution. The P-6 system has a MicroHead 5 SR (standard range) with a vertical range of 327 µm and is capable of scanning at forces between 0.5 and 50 mg. The P6 offers high resolution 2D and 3D analysis of surface topography and 2D stress analysis. The stage is fully automated for precise positioning.

A step height repeatability of 6Å or 0.1% (1σ), a noise floor below 1nm RMS as measured on the scan stage, and a sub-Angstrom resolution capacitance sensor translates into the most repeatable, and sensitive ultra-thin film step measurements, roughness/waviness measurements, and accurate curvature reproduction. The system is capable of 150mm scan length.

1.3 Safety

1.3.1 This machine is connected to **110 VAC.** Be very careful and aware of electrical hazards. If you encounter any electrical malfunctions, contact Nanofab staff immediately

1.3.2 This machine has no EMO (Emergency Off), If electrical must be removed from system it must be unplugged.

1.3.3 The stage is capable of automated movement, take care not to pinch your fingers.

1.3.4 Read any posted **Nanofab Engineering Change Notices (ECN)** for any hardware, process or safety changes before running the tool.

2 HARDWARE

2.1 P6 Profilometer main frame component

2.2 Computer and Computer Monitor

3 REQUIREMENTS

3.1 Training

You must be a qualified user on the KLA Tencor P6 Profilometer. It has three scanning modes. The standard single scan, where you can pick out a particular position on your sample and scan it. A multiple scan up to 10 times and calculates the mean, standard deviation, minimum, and maximum of the parameters selected. Then a automatic sequence mode guides the operator through scanning multiple sites and automatically creates a scan sequence. As long as you position the sample in the same position every time you may use the auto sequence which will create a report of the data with a statistical summary. The system can take a reading with a standard scan left to right and from right to left with limitations. Reservations are required.

3.2 Restrictions

3.2.1 The 2D Stress Analysis is a Nanofab Staff assisted function.

3.3 System checks

3.3.1 Turn on system Computer.

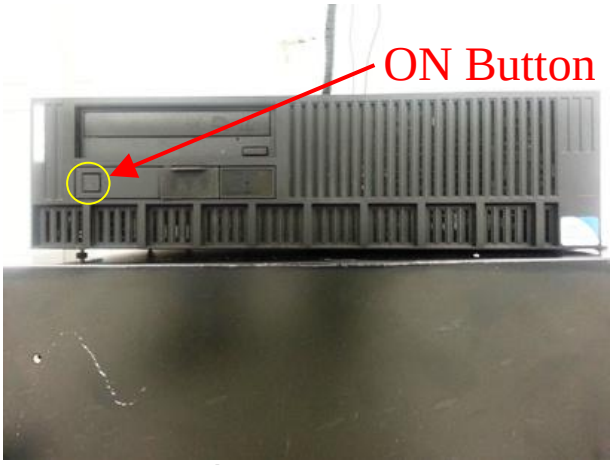

Fig. 3.3.1

4 OPERATING PROCEDURE FOR 2D SCAN

4.1 System Login

4.1.1. Login to the system's computer by clicking on the "Profiler 7.4" icon.

Fig. 4.1.1

4.1.2. When it asks for a password enter the word "student" in lower case letters. See the RED Circle in Fig. 4.1.2 .

Fig. 4.1.2

4.1.3 This is the initial screen as it appears that you will use.

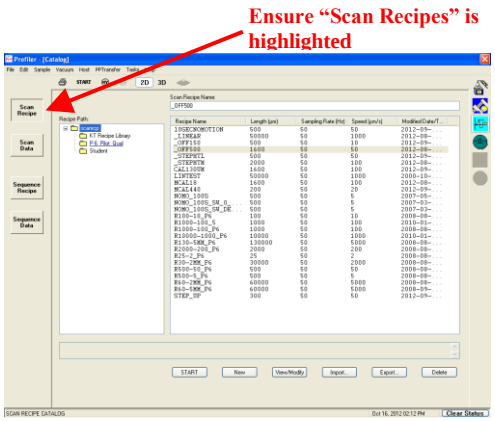

Fig 4.1.3

4.2 Equipment Alignment

4.2.1 Go to the (XY) button and click on it.

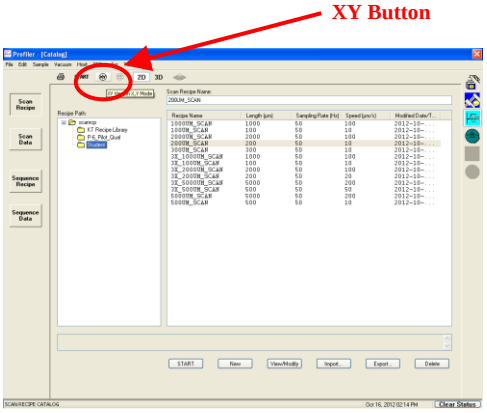

Fig. 4.2.1

4.2.2 This will bring up the Profiler Scan Window. Click on "Man Load" Button.

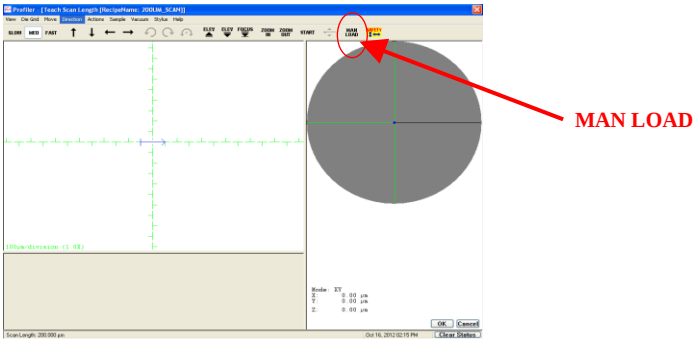

Fig. 4.2.2

4.2.3 This will bring the stage out to a load position automatically. Lift the plastic protector door and place your sample on the stage center in the square or on top of the square.

Fig.4.2.3

4.2.4 Once sample is positioned, close the plastic protector door then go back to the Profiler Scan Window and press the "MAN LOAD" button again and it will position the stage centered under the stylus.

Warning: Stage "WILL NOT" move if the plastic protector door is OPEN, it *MUST* be Closed

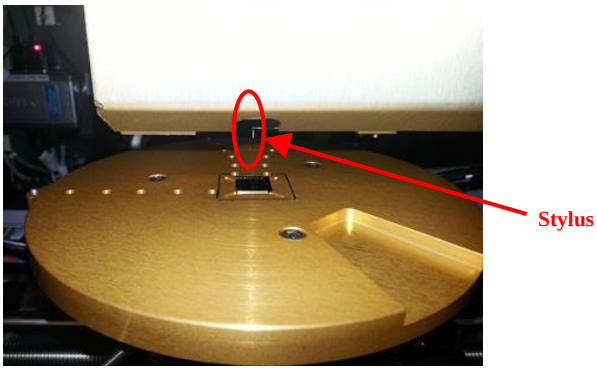

Fig. 4.2.4

4.2.5 Next go back to the Profiler Scan Window and locate then press the "FOCUS" Button.

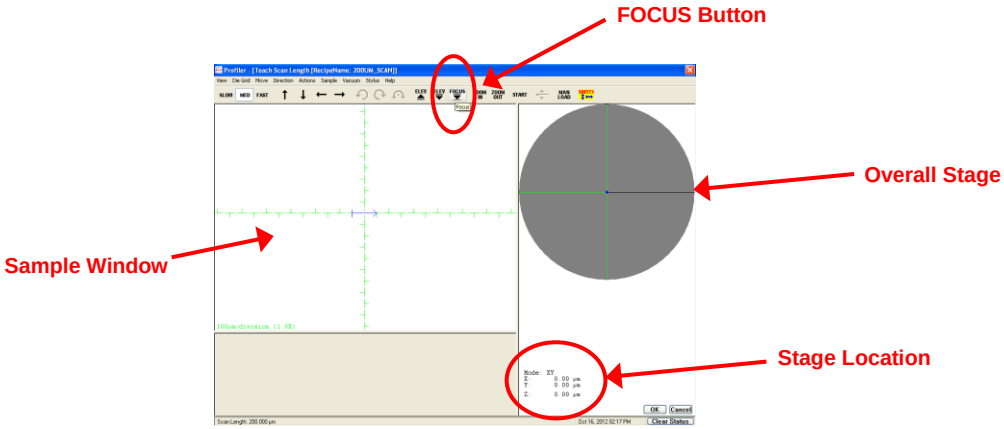

Fig. 4.2.5

4.2.6 This will bring the stage up to where the stylus just touches the sample and focuses the camera and light.

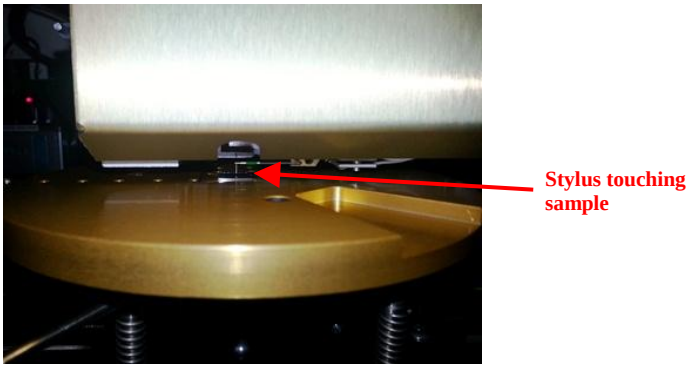

Fig. 4.2.6

4.2.7 Next you need to position the sample where you want to measure it, to make big moves go to the right side of the screen and put the (**+)** on an area where you want to go and click on it and the stage will move there. For smaller and more precise movements go to the left side of the screen and put the (**+**) on where you want to go and click it and the stage will move there automatically. Center your sample in the cross hairs, then go to the "OK" in the bottom right of the screen and click on it. This will take you back to the Profiler (Catalog).

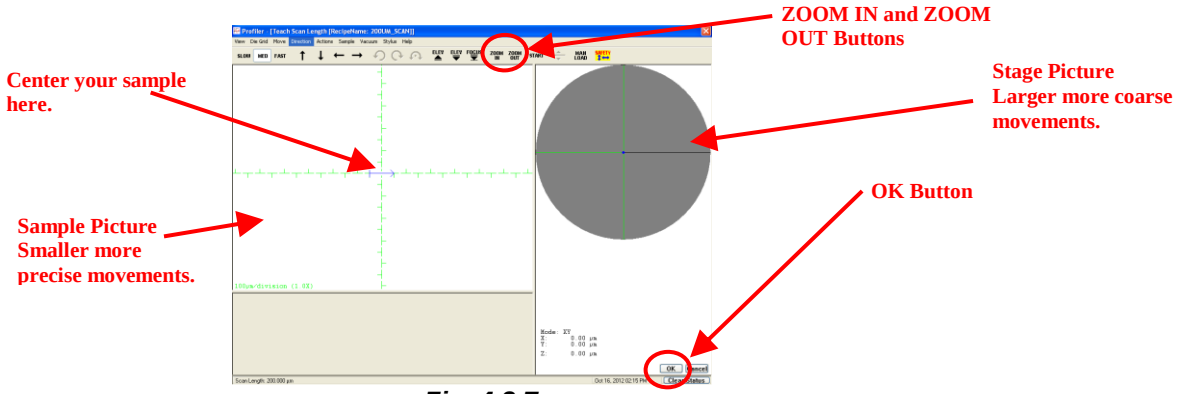

Fig. 4.2.7

4.2.8 You can use the "ZOOM IN" and "ZOOM OUT" buttons at the top to be more precise in your location. See Figure 4.2.7 above This only works on the left side sample view.

4.3 Measurement

4.3.1 At this point you should be at the Profiler (Catalog) Screen. Ensure “Scan Recipes” is highlighted.

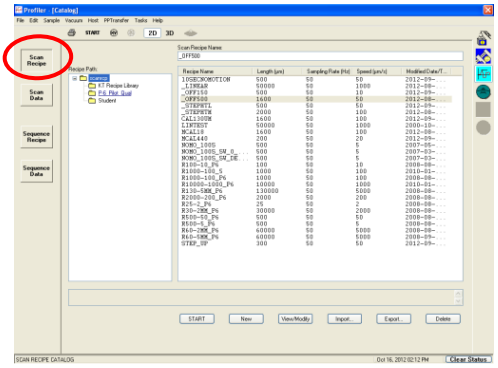

Fig. 4.3.1

4.3.2 In the window move over to “Recipe Path”, under “scanrcp” moved down to “Student” and click on to highlight and display the library.

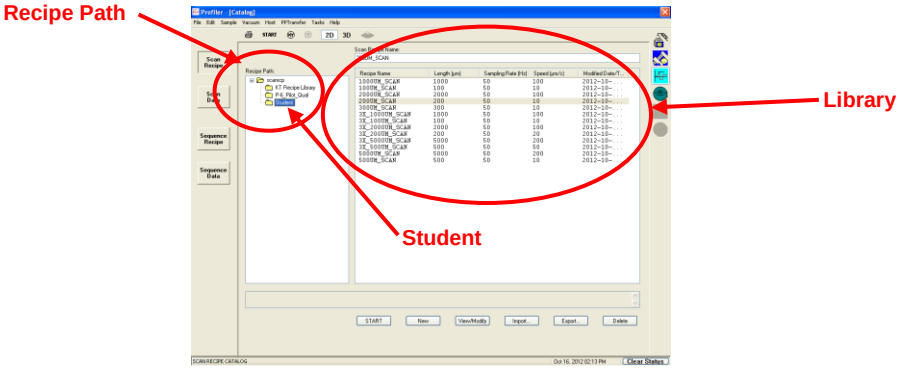

Fig. 4.3.2

4.3.3 Next choose your recipe by clicking on it one time to highlight.

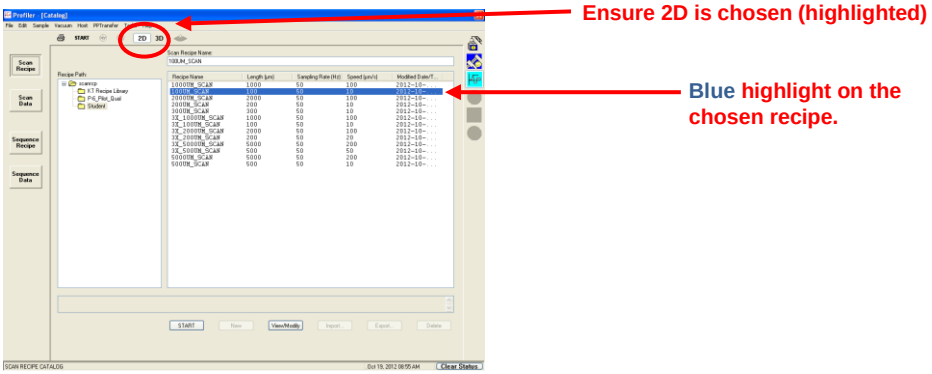

Fig 4.3.3

4.3.4 You should be positioned where you want the scan to take place and you should have choosen the recipe you wish to use in 2D. Next you are ready to start the scan by going to the bottom of the screen and pressing “START”.

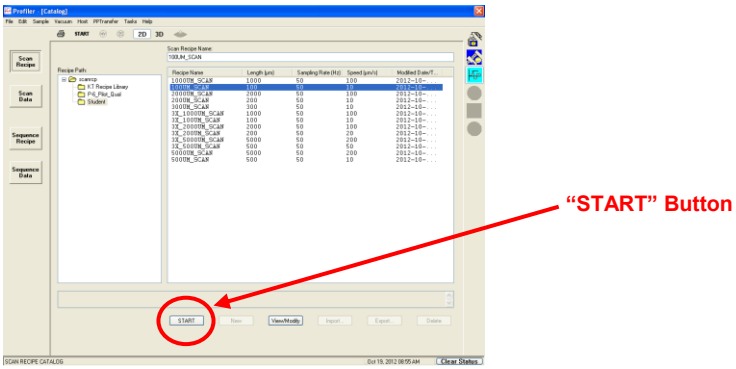

Fig. 4.3.4

4.3.5 This will pop up the Profiler Scanning Window, it will show a picture of your scan sight, but will not show you the actual scan on the left. On the right you will see the actual real time scan.

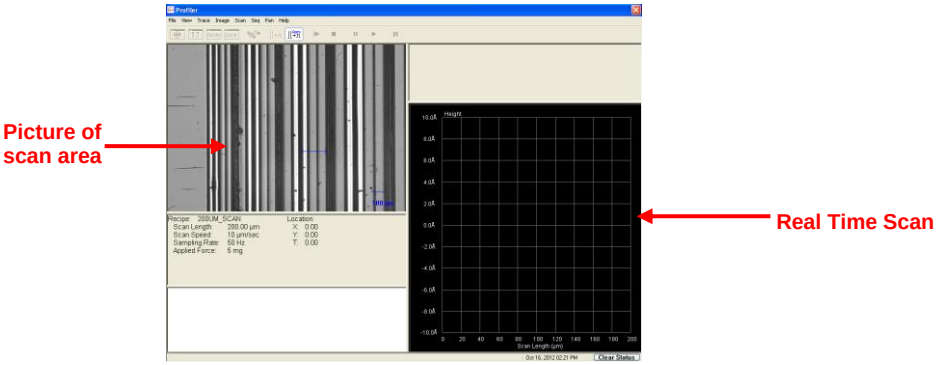

Fig. 4.3.5

4.3.6 When complete, the following screen will stay up briefly then switch to an Analysis screen.

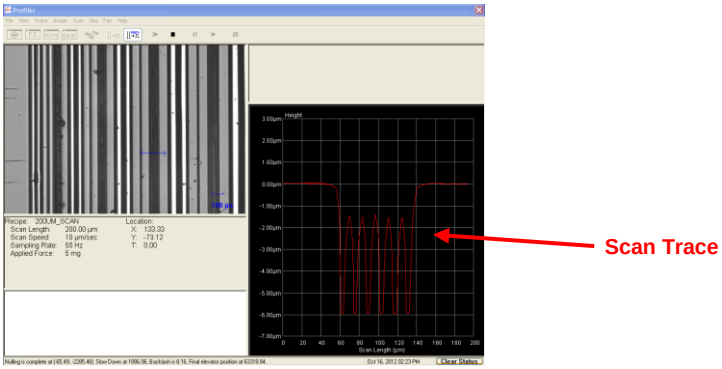

Fig. 4.3.6

4.3.7 You are now at the “Analysis Screen”. First you must get the top menu activated, you do this by moving the arrow to the Scan Data trace at the bottom and clicking on it. This will activate the upper menu.

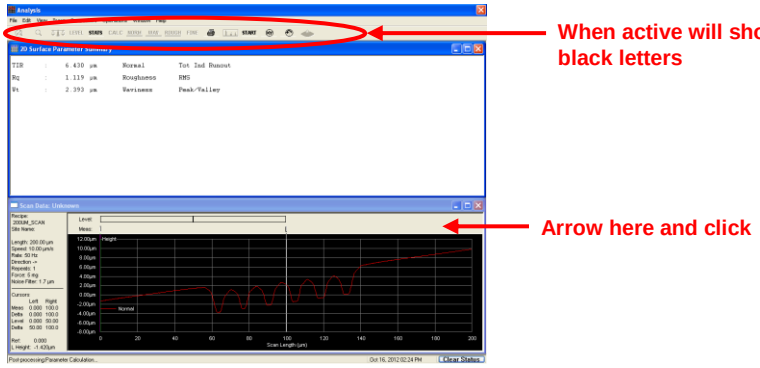

Fig. 4.3.7

4.3.8 Once the menu bar is active the first thing you want to do is Level the trace. Click on the “LEVEL” button and that will activate the top right and left leveling cursors. Put your arrow over them at the top and move the whole set. Move down into the chart and move one leg of a cursor at a time. When done push the “CALC” button at the top.

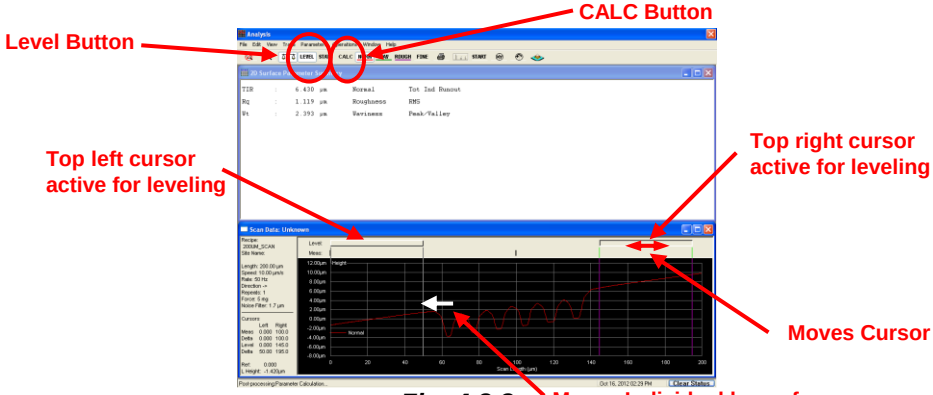

Fig. 4.3.8

4.3.9 The trace is now level and you can take your measurements. You lower cursors are now active, they move and function in the same way as the upper cursors did. You now have your measurements on the left side.

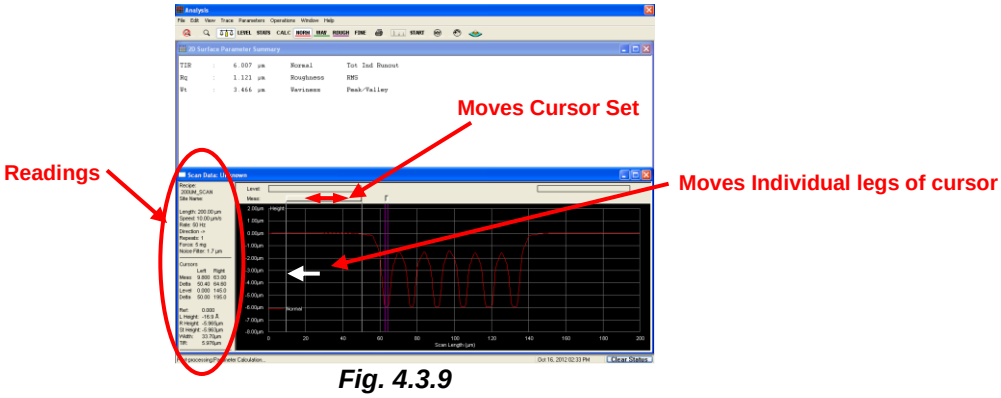

Fig. 4.3.9

4.3.10 You can also “Zoom In” on a particular area by going to “Operations” and move down the menu to “Zoom” and clicking on it. You will use cursors much the same as for leveling and measurements to define your area. Once you have zoomed into the area that you want you must go back to “Operations” and uncheck the “Zoom” to work in the new area.

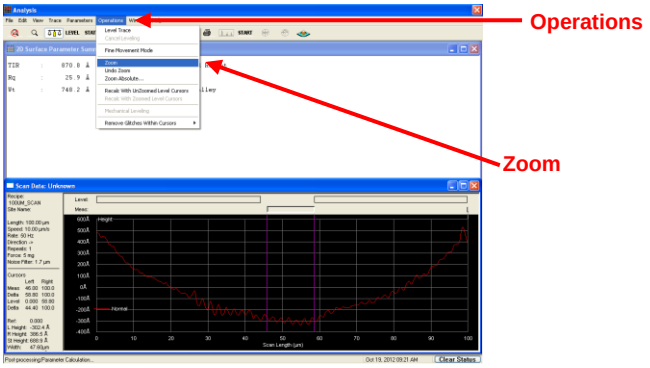

Fig. 4.3.10

4.3.11 You can also define the area you want to zoom into if you know the coordinates by going to the “Operations” button and move down to the “Zoom Absolute” function and click on it. A Coordinates box will appear, you enter your coordinates and the analysis will zoom to the area.

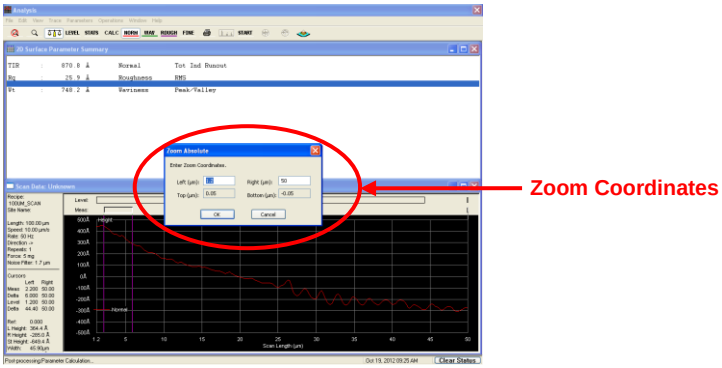

Fig. 4.3.11

4.4 Saving Data

4.4.1 To save the data for future reference go to File, then to Save Data and click on it. Save it to the Nanofab Group drive in your folder.

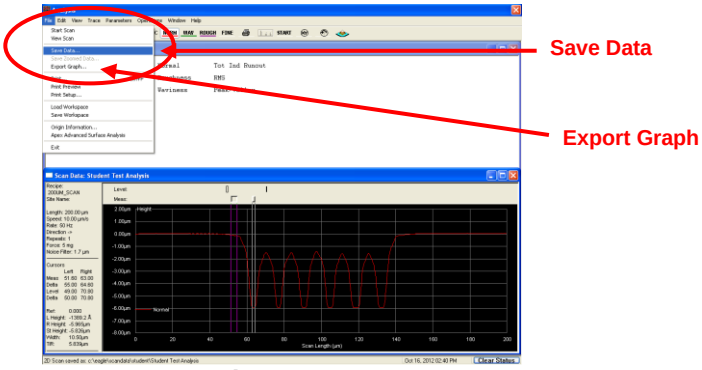

Fig. 4.4.1

4.4.2 You may also “Export Graph” by going to the “FILE” menu drop down as before and move down to “Export Graph”. This will save only the graph in a .bmp, .eps, .tif, .wmf, .jpeg file formats and you can place them in proper data folder as described above.

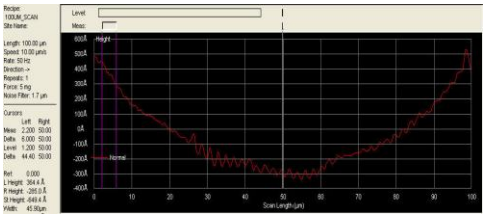

Fig. 4.4.2

4.4.3 You can also save it as a picture in .bmp format by pressing Print Screen on the keyboard. Then pushing the Windows key on the keyboard, this will allow you access to the Startup Menu. In this menu you will find the Paint program, click on it to open it up, then do a Paste and then save your picture the same as before.

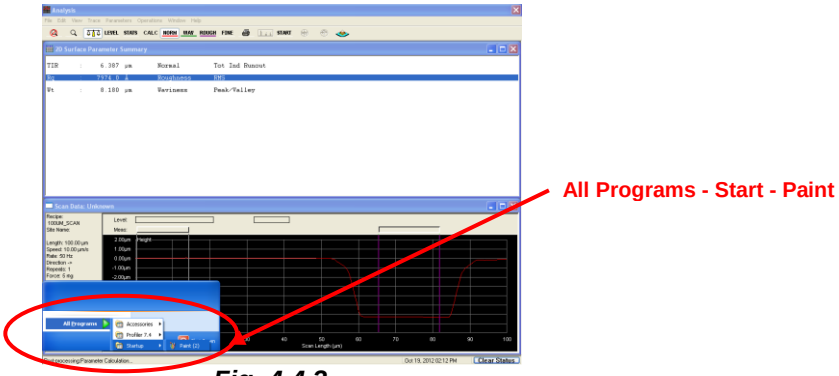

Fig. 4.4.3

4.4.4 Once complete move cursor to top right of screen to close it, or you may go to the Apex software and do more advanced measurements, See Appendix “B”.

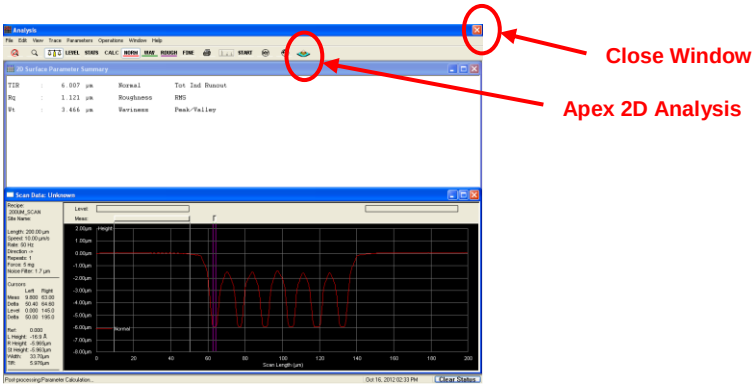

Fig. 4.4.4

4.4.5 You should now be back at the “Profiler (Catalog)”. At this point you may take another measurement, in which you would follow steps 4.2.7 to 4.4.4. Or you will need to shutdown the system.

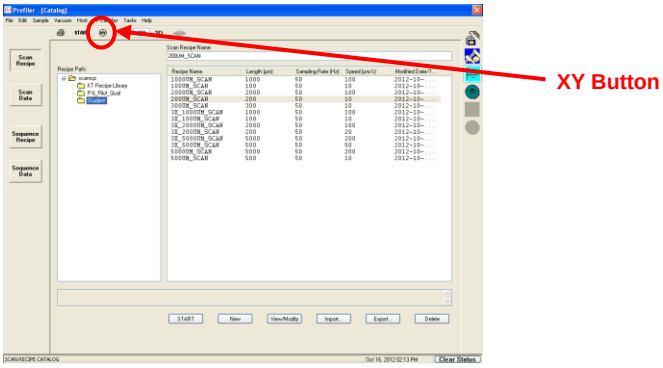

Fig. 4.4.3

4.5 Shutdown

4.5.1 First go to XY and click on it to take you back to the “Profiler Scan” Window. Then press “MAN LOAD”, this will bring the stage to the front so you can unload your sample.

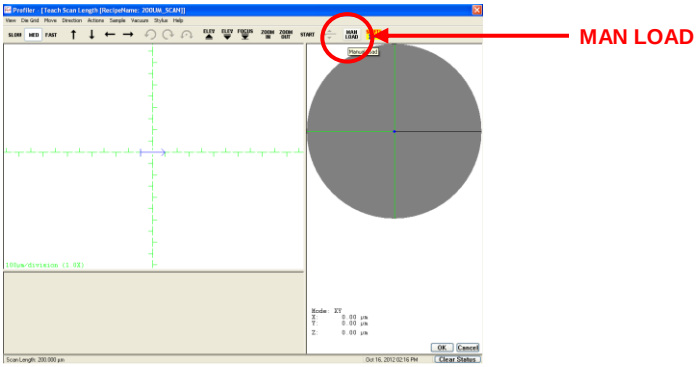

Fig. 4.5.1

4.5.2 Once you have unloaded your sample, ensure the plastic protective door is closed. Then either click “OK” or the “X” box in the top right of the screen.

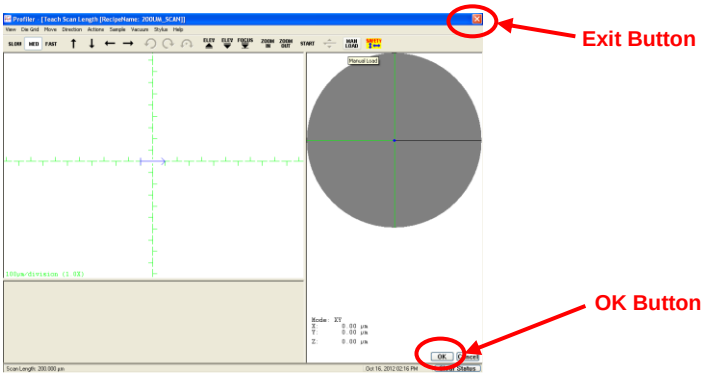

Fig. 4.5.2

4.5.3 This will take you back to the “Profiler (Catalog)” screen. Then either click on the “FILE” drop down and move down to “Exit” and click or go to the top right and click on the “X” box.

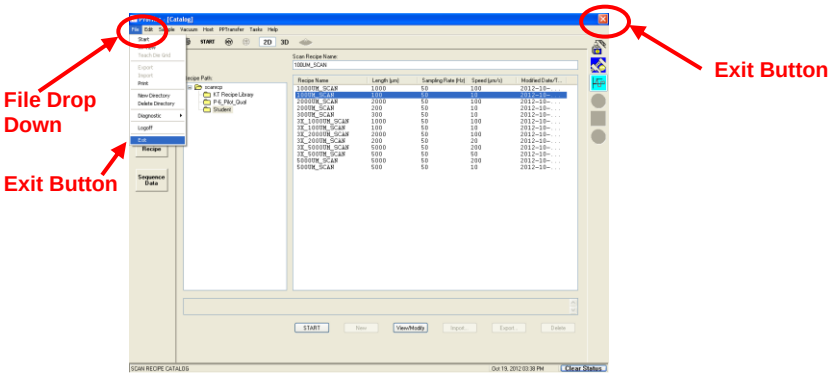

Fig. 4.5.3

4.5.4 It will ask you if you are sure you want to exit the program, answer Yes.

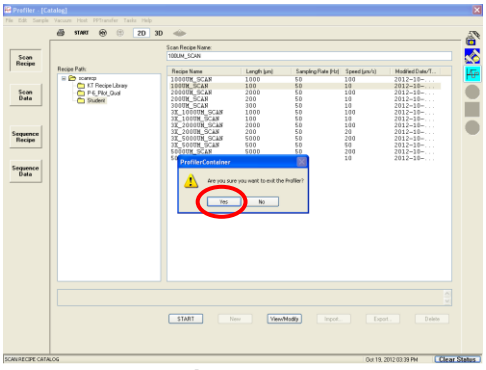

Fig. 4.5.4

4.5.5 This will take you back to the Windows desktop then stardard shutdown procedures apply.

5.0 Appendix

A. 3D Analysis Procedure

The 3D scan data analysis displays the 3D scan image and trace information after a scan is completed. A 3D scan is an image built by taking a series of 2D scans, arranged in a raster pattern, to form a picture of the sample surface at the scan location. With 3D analysis, complete surface analysis can be performed.

A.1 Follow the procedure above only thing that will change is at 4.3.3 you will click on the 3D on the Profiler (Catalog) at the top center instead of using the the 2D function. All other functions are the same in reference to loading and finding measurement spot as in 4.2 above.

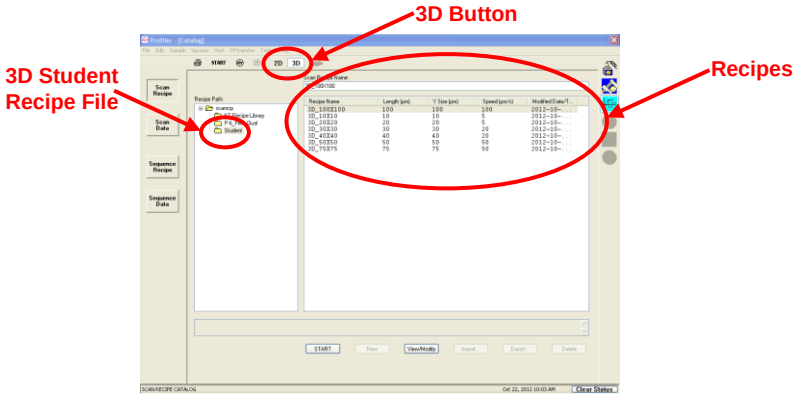

Fig. A.1

A. 2 This is the screen that will appear when you run the 3D scan.

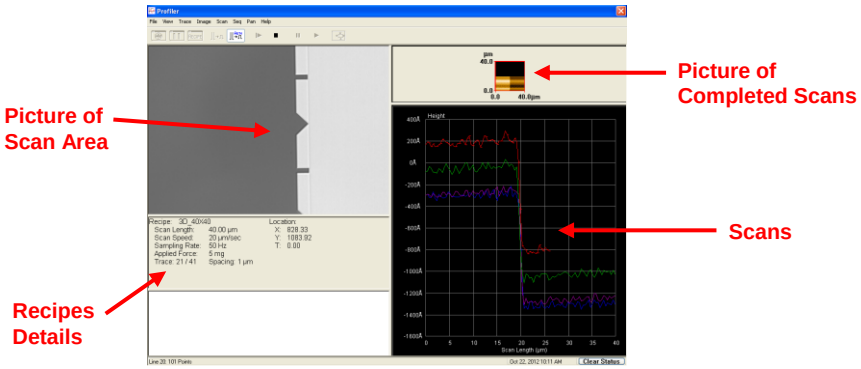

Fig. A.2

A.3 Once Scanning is complete the analysis window below will pop up. The top menu bar has to activated as it was in 4.3.7. Click in the lower display area.

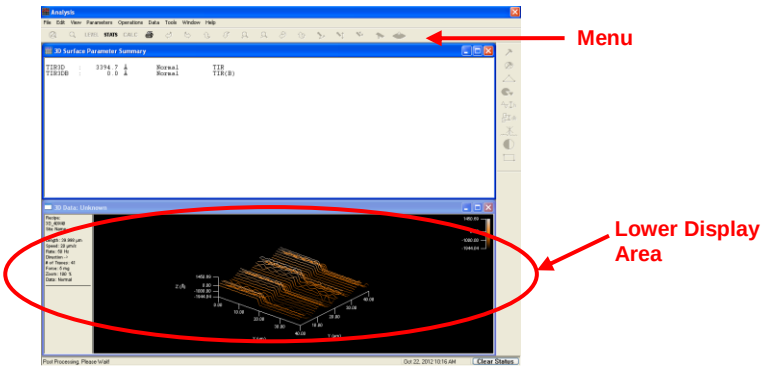

Fig. A.3

A.4 Below are commands to rotate your image.

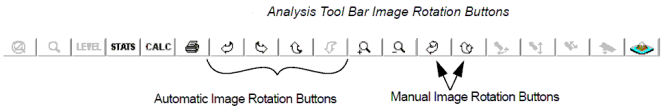

Fig. A.4

A.5 Click one of the handles and while holding down the mouse button, drag the image to rotate it to a different orientation in the chosen plane. Release the mouse button to set the image in its new orientation.

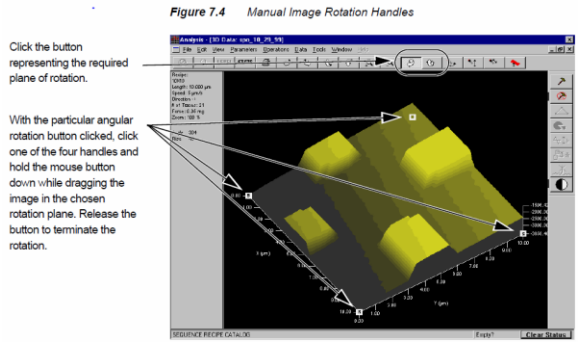

Fig. A.5

A.6 The Zoom features are designed to facilitate zooming in on a portion of the 3D graphic for closer inspection. The zoom can be accomplished through the use of several zoom tools.

a. The View Menu contains zoom features.
b. The tool bar contains zoom features shaped like magnifying glasses.
c. The Right-Click menu contains zoom tools.
d.  **Zoom Out** tool. This returns the image to its pre zoom magnification. This tool works with the Zoom In tool described above. It is for use after zooming in on a bounded area.

Analysis Screen – Using the Zoom In Icon

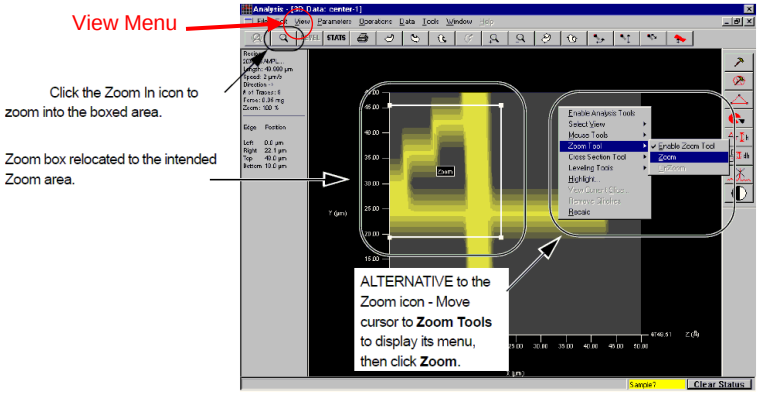

Fig. A.6

A.7 **LEVEL** icon. This is for use with the three point leveling tool. It is used as a trigger to execute leveling of the data according to the three vertex positions set using the Leveling Tool.

Procedure:

a. Click the **Hammer**  in the Analysis Tool box (on the right side of the image), The Analysis Tools are enabled.

b. Click the **Leveling Tool**  . The **LEVEL**  icon is enabled.

c. Use the click-and-drag procedure (click the center of each vertex) to position them. (For more information on the procedure, see *Activate Leveling Tool on page 7-13 of the P6 User Manual*.)

d. Click the **LEVEL**  icon to complete the leveling procedure.

A.8 **Statistics** 

information box. This displays the statistics information box on the screen, usually beneath the analysis image. The positioning can be manipulated.

A.9 **Print**  . This causes the system to print the analysis information.

A.10 **Move highlight planes**  . This moves each highlighted plane for visibility. Up to 10 planes can be identified for viewing.

A.11 **Enable Analysis Tools**  **(Top View)**. This button enables the remaining tools in this tool bar. It moves the image to the **Top View** because all the tools require this view.

A.12 **Disable analysis Tools**  . This button disables active tools. This includes the tools in this tool bar as well as those in the top tool bar.

A.13 **Activate Height Tool** 

. This button activates the tool that places a box on the image surface. The box borders an area containing data that is averaged to give a single average height of the contents of the box. Using the center of the box, it can be moved using the click-and-drag procedure. The handles at the corners of the box can be used to change the area of the box. The data is automatically calculated as the box is moved, or as its area is changed by moving its borders.

A.14 **Activate Slicing Tool**  . This button activates the tool that allows the user to slice the image down from the top surface to the foundation of the image and display a 2D image of the cross section at the slice. This tool provides three options for the slice: horizontal, vertical, and diagonal. (Diagonal can be adjusted to any angle.) All three options can be adjusted to any length.

Procedure:

a. When this tool is clicked, a slice line is displayed on the 3D image in the chosen orientation.

b. Click and hold while dragging the slice line to the desired location on the image.

c. Adjust the length of the slice by using the click-and-drag procedure with one of the handles at the end of the slice line.

d. Right-click to display the Right-click menu. (See next page.)

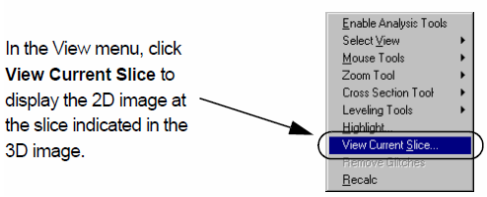

Fig. A.14.d

e. Click **View Current Slice** (shown above) to view the current slice trace. To display both the 2D image along with the 3D image (as illustrated below), click **Window**, then choose **Cascade**.

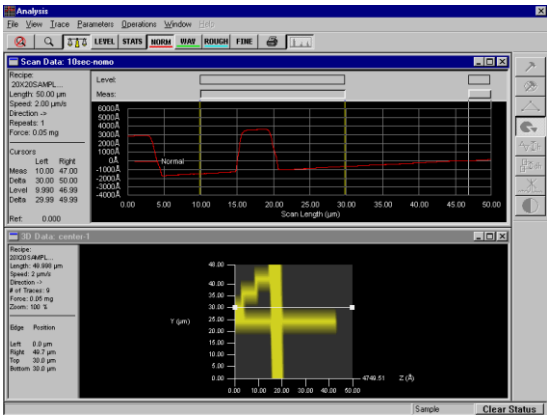

Fig. A.14.e

A.14 **Activate Step Height Tool** 

. This button activates the tool that places two boxes on the image surface. Using using the click-and-drag procedure with the center of each box, it can be moved to a new location on the image surface. It can then be resized using the corner handles. The software determines the difference between the average height in one box and the average height in the other box. This difference is automatically calculated as the boxes are moved or resized.

A.15 **Activate 3D Glitch Removal Tool**  . This button activates the 3D glitch removal option. The tool is used in the following manner:

a. Activate the glitch removal button by clicking on it. A box is displayed at the bottom right of the top view of the 3D image.

b. Drag the box over an area that presents the identical but correct formation of the area that contains the glitch. Resize the box to capture only those attributes and only the size that is to be corrected in removing the glitch. (See left side illustration below. Note that it is important to gather enough data points for the system to make the analysis and remove the glitch.)

c. Right-click to display the right-click menu.

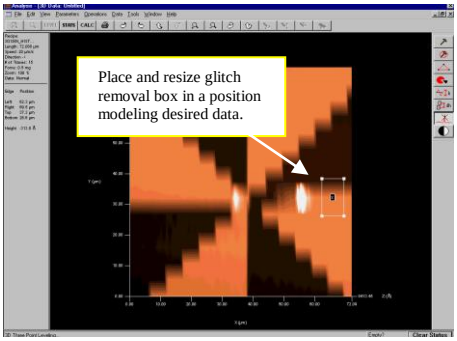

Fig. A.15.c.1

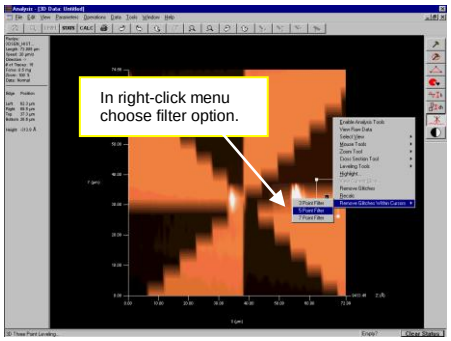

Fig. A.15.c.2

d. Move cursor to **Remove Glitches Within Cursors** and choose the median filter to be used; 3 x 3, 5 x 5, or 7 x 7. (See right side illustration above.)

e. Move the box over the glitch area, placing it in the same relative position that the initial box was placed. (See left side illustration below.)

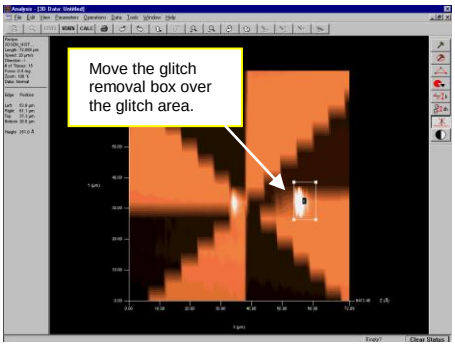

Fig. A.15.e.1

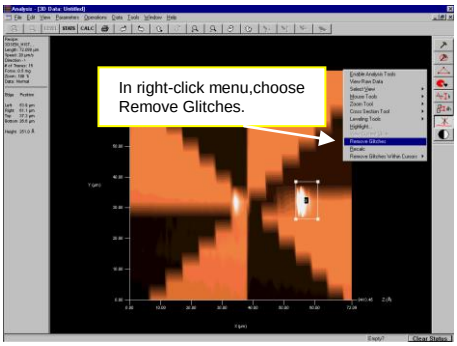

Fig. A.15.e.2

f. Right-click to display the right-click menu. (See right side illustration above.)

g. Move the cursor to Remove Glitches and click.(See right side illustration above.) The glitch is removed using the chosen filter and the data gathered in the first box.

A. 16 Save data as per normal step and sequences.

B. Apex 2D/3D Analysis Software

TBD