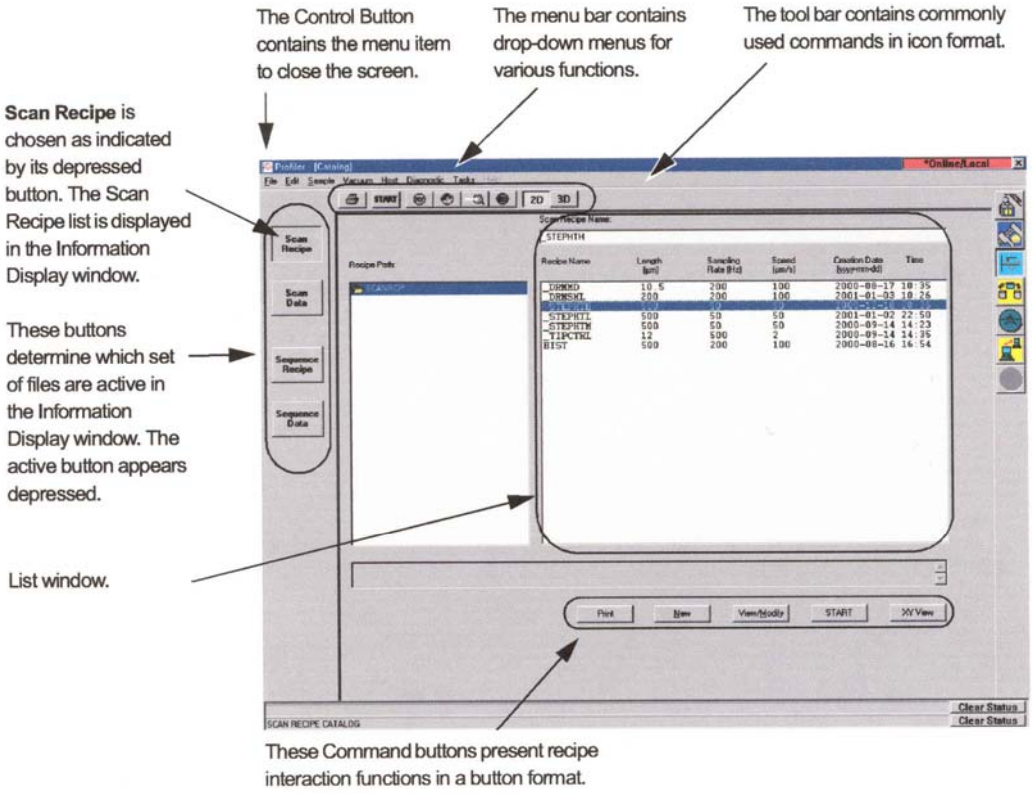
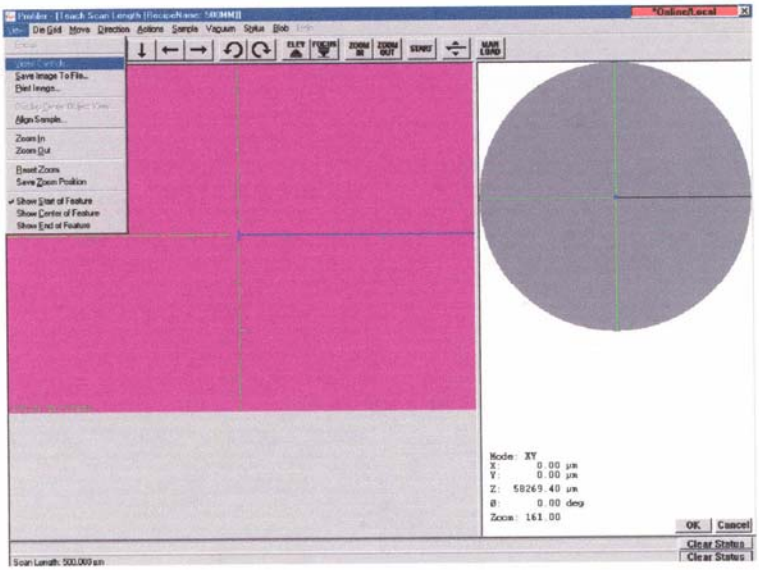
Instructions for P-15 surface profiler

Surface profiler software **Profiler Version 6.41** runs on Windows NT operating system. The program has three main subsets of screens:

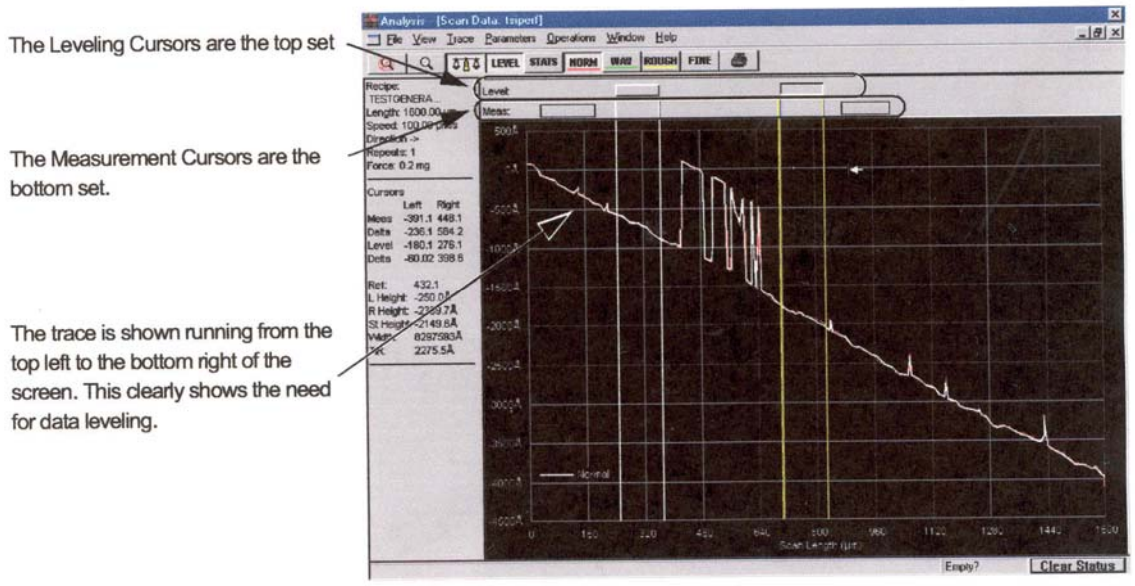
1. **Catalog** screen allows manipulation of the recipe and data files.



2. **XY** screen shows the video image of the sample and allows manipulation of the sample stage. It also allows to take and save video images.



3. **Analysis** screen shows the actual trace and allows the analysis of it.



The recipes are stored in **C:\eagle\scanrcp** and the data in **C:\eagle\scandata**. The users should create their own subfolders to store recipes and data. The basic recipes can also be found in **C:\eagle\scanrcp\General.** The data can be transferred via floppy or CD disk using **Database File Manager** (see below).

Upon double-clicking on **Profiler Version 6.41**, the main **Catalog** screen appears. The buttons on the right-hand side of the **Catalog** screen have the following functions:

Configuration

Calibration

Users may access only part of the information. However, never ever change any of the numbers. It will lead to malfunction of the instrument.

Scan (2D and 3D scans)

Database File Manager (export, import, delete files)

Stress (measurement)

2D and 3D scans:

1. Log onto Windows NT using your own login name and password.
2. Make sure that the vibration isolation table is on (the red button should be pressed).
3. To start the program double-click on **Profiler Version 6.41** and wait. The profiler performs a test and levels the stage. It is preferred that there is no sample on the stage during this procedure. The **Catalog** screen appears after the procedure is finished.
4. Click **Scan Recipe** on the left-hand side, **Scan** icon on the right hand side, and **2D** or **3D** in the top tool bar menu. Find your recipe in the appropriate folder and highlight it.
5. Click (XY) icon in the top menu to display the **XY** screen.
6. Click **MAN LOAD** in the tool bar to move the stage to the door. The stage moves to the door. Open the door.
7. Place the sample on the center of the stage. Turn on the vacuum switch located on the left inside edge of the door. The vacuum now holds the sample. Close the door.
8. Click **MAN LOAD** to move the stage back under the stylus head. The gray circle on the right side of the screen depicts the 8-inch stage and the blue dot represents the position of the stylus. The center of the stage moves under the stylus. **!!! Remember, the gray circle represents the whole stage, not just your wafer !!! This becomes important if you move the stage. While the blue dot remains within the gray circle, the stylus might be already away from your sample. It may be damaged upon lowering.**
9. Click the **FOCUS** button to null the stylus on the sample surface. The stylus head moves down, the stylus touches the surface of the sample and lifts again.
10. Click and hold **ZOOM IN** (**ZOOM OUT)** buttons if you need to change the magnification. Note that the scale of the graph that is superimposed on top of the video image does not change. **The scale corresponds to the lowest magnification** (to match the scale with the video image you need to **ZOOM OUT** completely).
11. Look for the feature that you wish to trace. Use the arrows (↓ ← → ↑) and the speed buttons (**SLOW**, **MED**, **FAST**) in the tool bar menu to move the stage at the desired speed. Click ↻ or ↺ if you need to rotate the stage. You also may click inside the gray circle and the stylus will move into that spot (actually the stage moves, the stylus does not). **Make sure that the stylus is still above your sample. ZOOM OUT** completely. The blue arrow in the video image indicates the trace of the scan.
12. a) Go to step 16 if you are ready to scan.
    or
    b) If you want to make changes in the scan (recipe), you need to return to the **Catalog** screen. Click **OK** and you will go back to the **Catalog** screen.
13. Open your recipe by double-clicking on it.
14. Adjust the parameters in your 2D/3D recipe with the following in mind:
    a) Adjust the **X Scan Size**, **Scan Speed**, and **Sampling Rate** in such a way, that the **Approx. Total** time is between 10 and 20 seconds (for a single scan) and **Point Interval** is at least 0.5 μm. Taking data more frequently than that provides no additional information because the radius of the stylus is 2 μm. If you would like to average several scans enter a number in the **Multi-Scan Average** window.
    b) Make sure that the arrow (➔) points to the right. Unless absolutely necessary, the scan always should be taken from left to the right.

c) Adjust the **Applied Force** of the stylus. Make sure you do not exceed the **Recommended Maximum**. The lower is the **Applied Force**, the lower must be the **Scan Speed**. If the **Applied Force** is 1-2 mg (for 2 μm stylus), the **Scan Speed** should not exceed 200 μm/s.

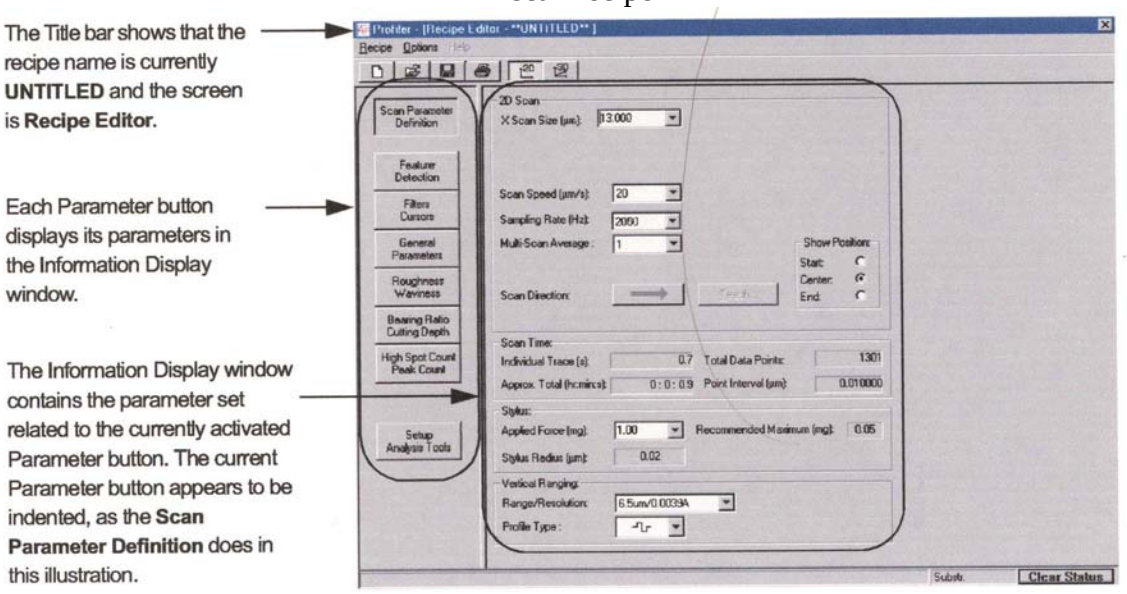
d) Knowing the approximate step height, choose the **Range/Resolution** and the **Profile Type**.

e) Save the recipe if you wish.

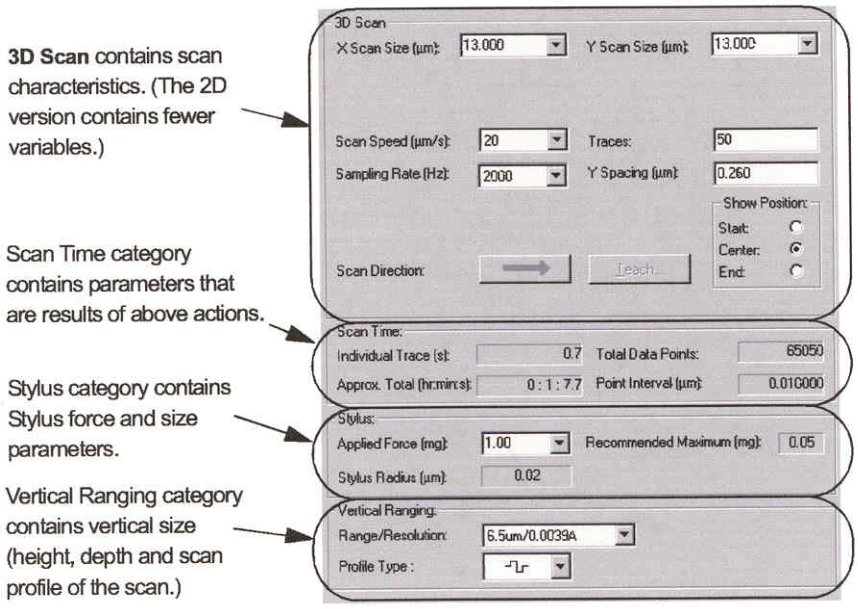
f) See the manual for programming **Feature Detection**, **Filters Cursors**, etc.

g) For **3D** scans, also enter **Y Scan Size**, # of **Traces**, and **Y Spacing**. The minimum for **Y Spacing** is 1 μm. Check that the **Approx. Total** time is not too long.

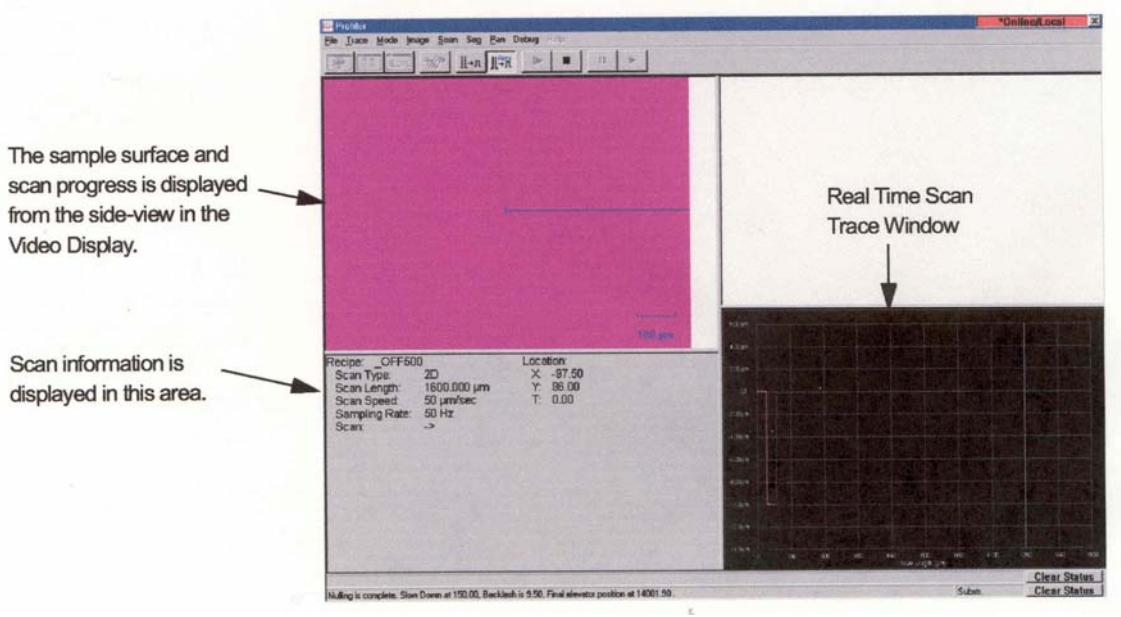
2D scan recipe



3D scan recipe



15. Click (XY) icon in the menu to display the **XY** screen. Check the trace of the scan.
16. Click **START** if you are ready to scan. The stylus will lower on the sample and scan the surface. **Make sure that the beginning of the scan is not too close to the sample edge, since the stylus will move ~ 300 µm to the left of the starting point.** The following screen will appear. Unless you choose otherwise, the **Auto Scaling** is automatically turned on.



Button	Description
	XY View Screen Icon – Changes to view the XY View screen.
	Analysis Screen Icon – Changes screens to view the Analysis screen.
RECIPE	**Recipe Editor Screen Icon** – Changes screens to view the Recipe Editor Screen
	Manual Scaling – Resizes the trace to fit in the graph. Requires operator initiation.
AUTO	**Auto Scaling** – Automatically resizes the trace after each scan.
	START SCAN – Starts a stopped scan. The scan that was stopped begins again from the start, the prior partial scan is not retained.
	STOP SCAN – Stops a scan that is in process. A stopped scan cannot be started again from the place in the scan where it stopped. The scan begins again from the beginning.
	PAUSE SEQUENCE – N/A for single scans.
	START/RESUME SEQUENCE – N/A for single scans.

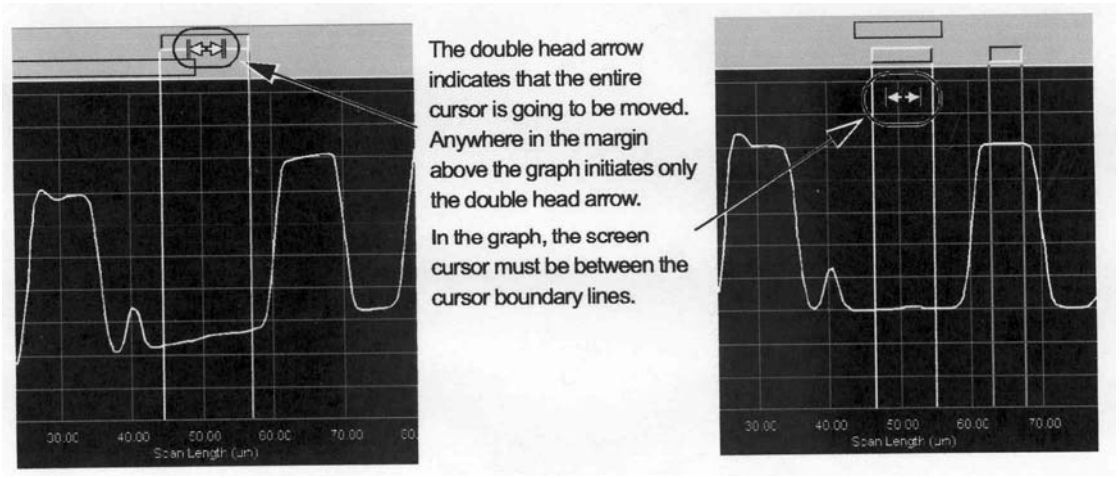
17. After the scan procedure is completed, the **Analysis** screen appears with your "live" data. The "live" data has the following attributes:
    a) It is data which has just been collected from a scan.
    b) It has not been saved and is therefore untitled.
    c) This data can be manipulated by changing the parameters in the recipe used to create scan.

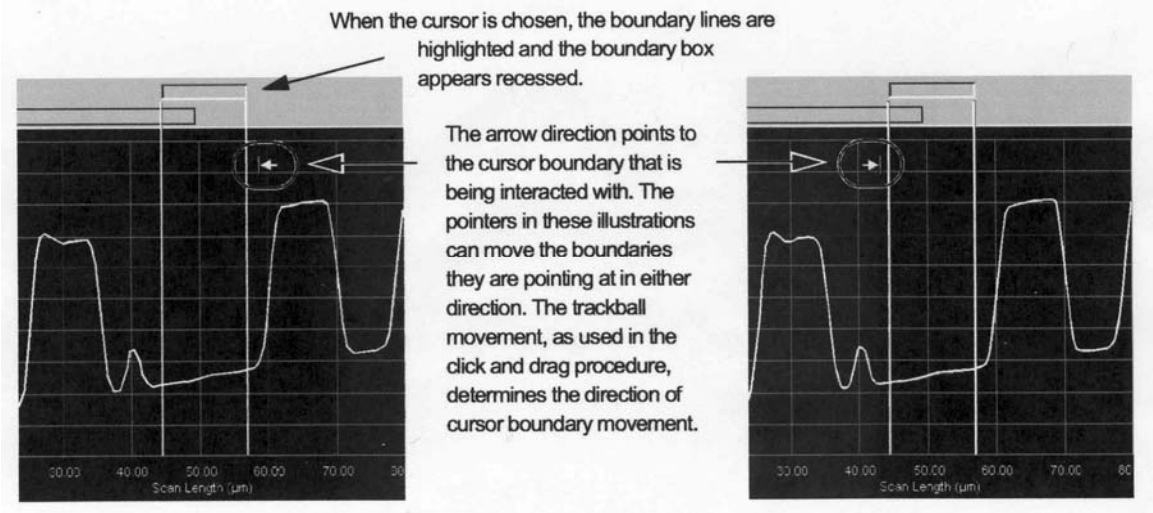
    If the data has been saved, it is no longer "live". It has the following properties:
    a) Its name appears in the **Scan Data** of the **Catalog** screen.
    b) It must be opened through the **Analysis** screen in order to view or reanalyze it.
    c) It can be reanalyzed by changing the **Scan Recipe** parameters.

Tool bar menu of the Analysis screen

Button	Description
	Displays the graph view in the original view size.
	Activates the zoom capability. To focus on a certain part of the graph, use the cursor boundaries to define the zoom-in area.
	Turns the Auto Scale Function for the zoom capability on and off.
	First click activates the LEVEL cursors. Second click levels the trace according to cursor settings and activates the Measurement cursors.
	Opens the Surface Parameter Summary window. If the Surface Parameter Summary window is currently minimized, it appears maximized upon clicking this button.
	This initiates a recalculation of the data using newly chosen parameters from the recipe used for the scan. This can be executed on both live data (not yet saved) and saved data that was collected using the Software version 6.1 or higher.
	Toggles, ON/OFF, the normal trace graph.
	Toggles, ON/OFF, the waviness trace graph.
	Toggles, ON/OFF, the roughness trace graph.
	Activates Fine Cursor Movement mode of measurement and leveling cursors.
	Prints the Analysis graph and the surface parameter summary.
	Show/Hide Major Modes for the Histogram.

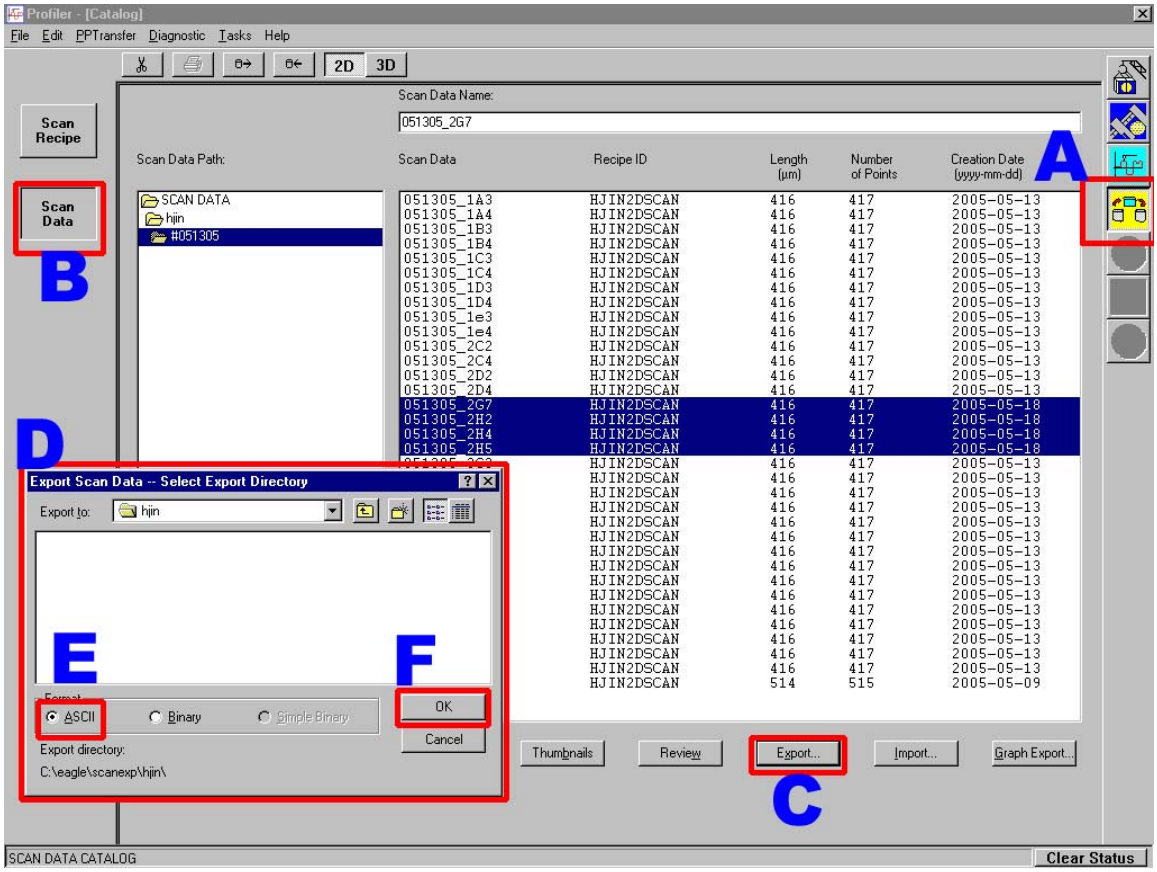
18. Click **LEVEL** and adjust the level cursors. You may move and resize them as shown below. Each cursor can be selected and moved using the mouse. You also may select the cursor(s) with space bar and move it/them with arrows (← →) on the keyboard. If you click **FINE** and then move cursor with the arrows, the cursor will move through every data point.





19. Click **LEVEL** and the trace will be automatically leveled.
20. Move and adjust your measurement cursors. The position of all cursors is shown on the left of the screen. **L Height** and **R Height** display the height of the left and right cursors, respectively. The **Width** measures the distance between the centers of the measurement cursors. The length of the cursor determines the area over which the data is averaged. Each cursor can be reduced to a single line (point). Use this feature to measure **Width**.
21. If desired, perform the rest of the analysis and save the data.
22. Click (XY) icon in the top menu to return to the **XY** screen.
23. Click **MAN LOAD** to move the stage forward. Open the door, turn off the vacuum, and remove the sample. Load another sample and take another scan, if desired.
24. Exit the program and logoff. ☺ **Do not forget the log book** ☺

Exporting raw data (ASCII) from saved scan data:



1. Click on **Database File Manager** found on the right side of the screen (marked A).
2. Click on **Scan Data** on the left (B).
3. Locate data files to be exported and highlight them.
4. Click on the **Export…** located at the bottom of the screen (C).
5. **Export Scan Data** window will pop-up (D).
6. In this window first select the folder where you want to save your exported files. Then select **ASCII** (E) format.
7. Click on **OK** (F) and the program will export selected data files and save them as **.txt** files. The exported files retain the original file names. Example of an exported file is shown below.

Data 051305_1A3
Recipe HJIN2DSCAN
Points 417
X-Resolution 1.000000

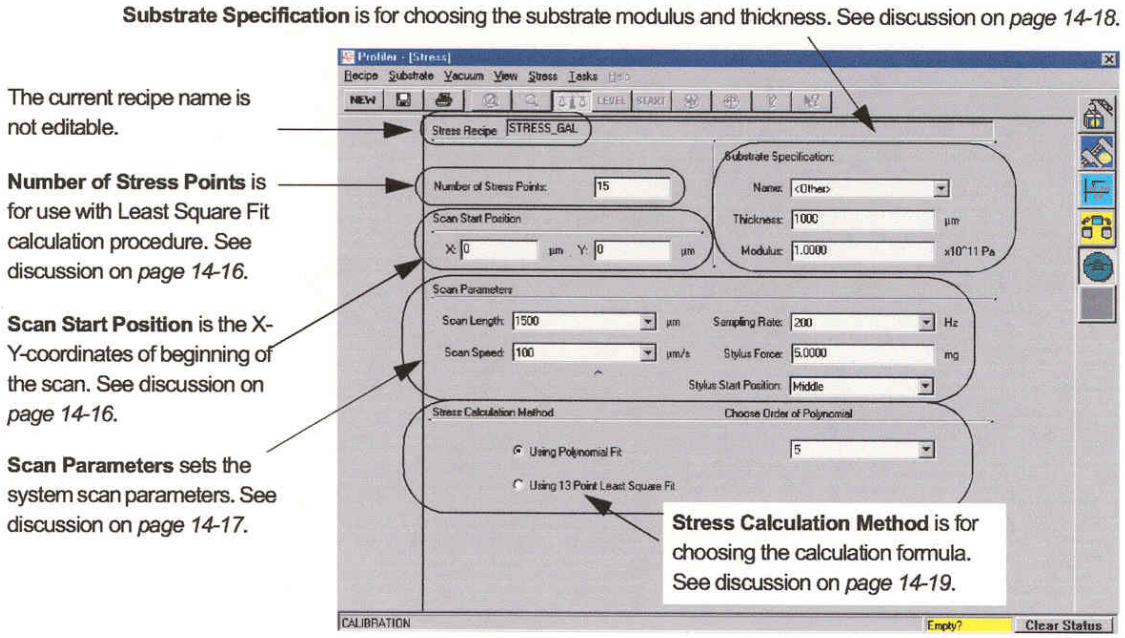
	Raw	RawLevel	Normal	Rough	Wavi
1	-2015.51	-39.51	-39.5101	-39.5101	-39.5101
2	-1978.15	-12.3452	-12.3453	-12.3453	-12.3453
3	-1951.34	4.26331	4.26324	4.26324	4.26324
4	-1954.7	-9.29248	-9.29254	-9.29254	-9.29254

…

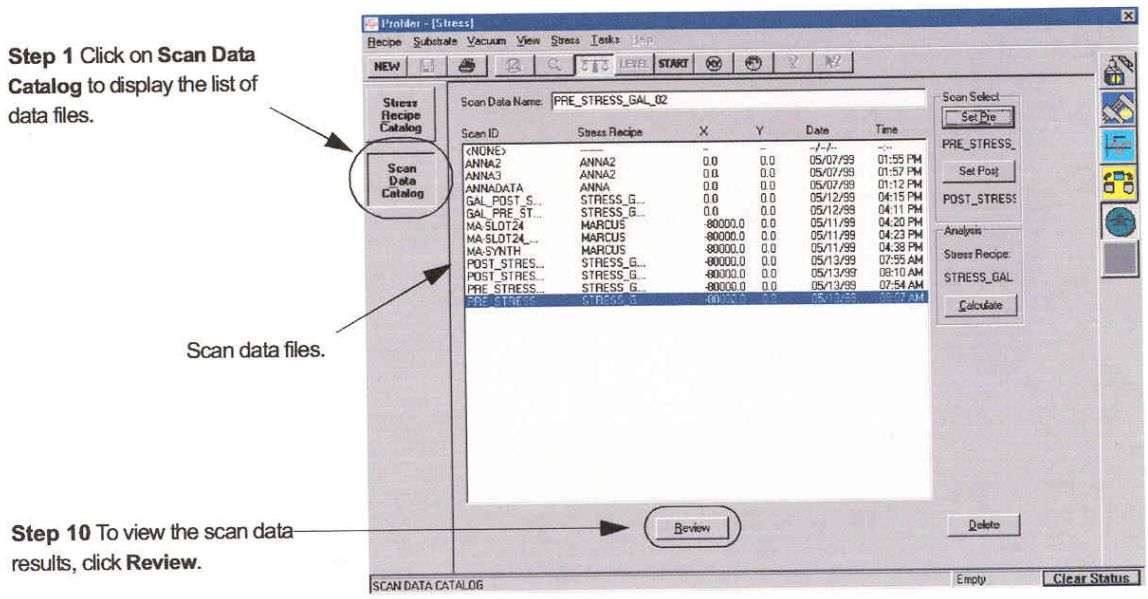
Stress Measurement:

1. Double-click on **Profiler Version 6.41** and wait. The profiler performs a test and levels the stage. It is preferred that there is no sample on the stage during this procedure. The **Catalog** screen appears after the procedure is finished.
2. Click the **Stress** icon on the right hand side of the **Catalog** screen. The **Stress Recipe Catalog** will be displayed. Highlight your recipe. If you do not have any, you may use **STRESS_1**.
3. Click (XY) icon in the top menu to display the **XY** screen.
4. Click **MAN LOAD** in the tool bar to move the stage to the door. The stage moves to the door. Open the door.
5. Carefully place the stress holder on top of the sample stage, as shown below. Two pins on the bottom of the stress holder fit into holes of the sample stage. Place your bare, clean, four inch wafer on the stress holder. The flat side of the wafer should face to the right. Push the wafer against the round pins. **!!! Do not turn on vacuum !!!**

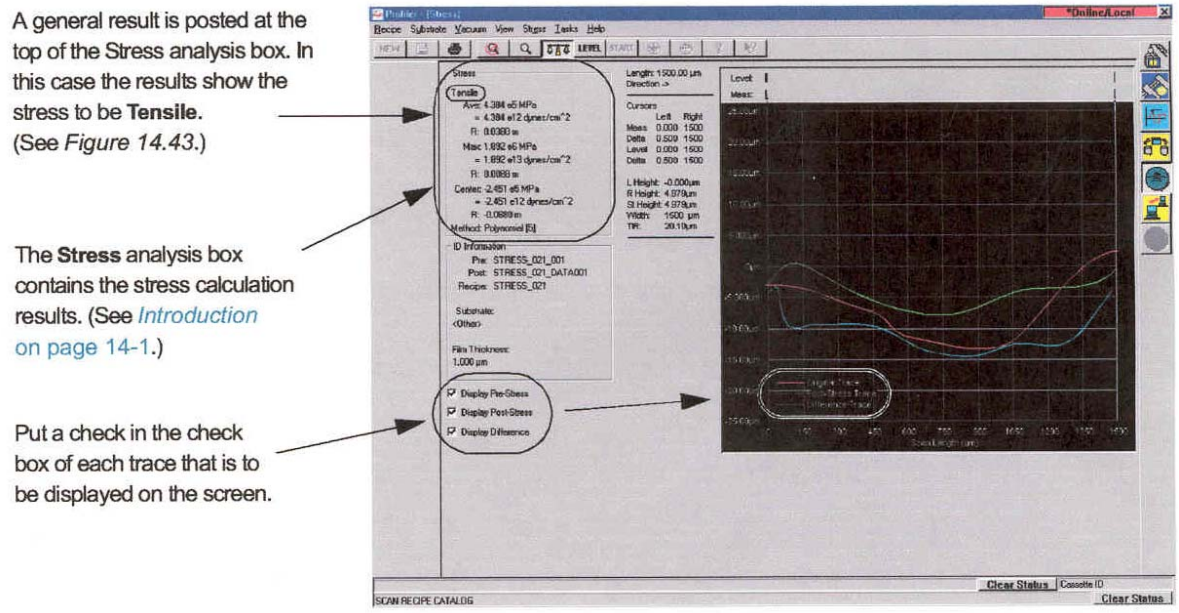
6. Close the door. Click **MAN LOAD** to move the stage back under the stylus head.
7. Click the **FOCUS** button to null the stylus on the sample surface. The stylus head moves down, the stylus touches the surface of the sample and lifts again.
8. a) Go to step 11 if you are ready to scan.
   or
   b) If you want to make changes in the recipe, you need to return to the **Catalog** screen. Click **OK** to get back to the **Catalog** screen. Double-click your recipe to open it. The following screen appears.



9. The **Scan Start Position** should be: **X** = -40000 and **Y** = 0. Set the **Scan Length** to 80000 (you should scan 80% of the wafer diameter to determine the stress) and **Sampling Rate** to the maximum value, choose the **Scan Speed** and the **Stylus Force** (the lower is the **Stylus Force** the lower should be the **Scan Speed**), and select **Middle** for the **Stylus Start Position**. In the right hand corner choose the type of wafer (substrate) and enter its **Thickness**. Select **Using Polynomial Fit** as the **Stress Calculation Method.** The best results come from fifth order polynomial. Save your recipe.
10. Click (XY) icon in the top menu to display the **XY** screen.
11. Click **START** to start the pre-stress scan. You should be scanning a bare wafer to establish the "baseline" for the stress calculation. A dialog box named **Scan ID** appears. Enter the name of the data file you are about to collect.
12. In the **Analysis** screen, minimize the leveling cursors. Move one of them all the way to the left and the other one all the way to the right. Level the trace.
13. Click (XY) icon to return to **XY** screen. Hit **MAN LOAD**. Click and hold the **ELEV** button to lift the stylus (elevator) all the way up. Unload the wafer and the stress holder. Exit the program and logoff.
14. Deposit a **single film** whose stress you want to evaluate on your wafer.
15. Take the post-stress scan **using the same recipe as before**. You should be scanning the original wafer with a film deposited on top of it.
16. Now you are ready to analyze the stress in the deposited film. This is accomplished through the comparison of the pre-stress and post-stress scans. The analysis is generated each time the calculation is performed. Click on **Scan Data Catalog** in the **Catalog** screen. A series of buttons will appear on the right side of the data file list.
17. Click to highlight the data file that contains the pre-stress data. Then click on **SetPre**. If you wish you review the data before hand, click **Review** before you click **SetPre**.
18. Click to highlight the data file that contains the post-stress data. Then click on **SetPost**.



19. Click **Calculate** to perform the stress analysis. If the recipes for the pre- and post-scan data do not match, a warning box appears and you cannot perform the stress calculation. If the data files are accepted for calculation, the **Film Thickness** dialog box appears.
20. Enter the film thickness in microns and click **OK**.
21. Next, the box titled **Polynomial Calculation Results** appears. Click **OK** to continue.
22. View the results on the **Stress Calculation Analysis Screen**.



23. Select **Manual Load** from the **Substrate** menu. Lift the elevator (stylus) all the way up. Carefully unload your wafer and the stress holder.
24. Exit the program and logoff. ☺ **Do not forget the log book** ☺