March 2005
0104396-000 AA

P-15 ™
User's Guide
for Software Version 7.0

EC COMPLIANCE

At the time of printing, the P-15 complies with the essential requirements of the EC (Electromagnetic Compatibility) Directives listed below

EC Directives	EC 89/392/EEC
	EC 89/336/EEC
	EC 73/23/EEC
Harmonized Safety Standards	EN 50082-2:1995
	EN 50081-2:1993
	EN 55011:1991
Harmonized Electromagnetic Standards	EN 60204-1:1992
	EN 61010-1:1993

COPYRIGHT

COMMENTS WELCOME

We welcome your comments about this document. Please e-mail them to Film and Surface Technology Technical Publications, or contact us at the address shown below. Please reference the document's part number in your communications.

Published March 2005

Printed in the United States of America

KLA-Tencor Corporation
Film and Surface Technology Division
160 Rio Robles
San Jose, California USA 95134
Phone: 408-875-4200
e-mail: gss.documentcontrol@kla-tencor.com

List of Figures

Chapter 1 Introduction

Chapter 2 Basic Skills

Chapter 3 Scan Recipes

Chapter 4 Stylus Change Procedure

Chapter 5 XY View Screen

Chapter 6 View Scan Window

Chapter 7 Sequence Recipe and Data (Optional)

Chapter 8 Analyzing 2D Scan Data

Chapter 9 Analyzing 3D Scan Data

Chapter 10 System Security

Chapter 11 Configuration

Chapter 12 Calibrations

Chapter 13 GEM/SECS Option

Chapter 14 Wafer Stress Application Option

Chapter 15 CMP Analysis Algorithms

List of Tables

Chapter 1 Introduction

Chapter 2 Basic Skills

Chapter 3 Scan Recipes

Chapter 4 Stylus Change Procedure

Chapter 5 XY View Screen

Chapter 6 View Scan Window

Chapter 7 Sequence Recipe and Data (Optional)

Chapter 8 Analyzing 2D Scan Data

Chapter 9 Analyzing 3D Scan Data

Chapter 10 System Security

Chapter 11 Configuration

Chapter 12 Calibrations

Chapter 13 GEM/SECS Option

Chapter 14 Wafer Stress Application Option

Chapter 15 CMP Analysis Algorithms

Table of Contents

Chapter 1 Introduction

Chapter 2 Basic Skills

Chapter 3 Scan Recipes

Chapter 4 Stylus Change Procedure

Chapter 5 XY View Screen

Chapter 6 View Scan Window

Chapter 7 Sequence Recipe and Data (Optional)

Chapter 8 Analyzing 2D Scan Data

Chapter 9 Analyzing 3D Scan Data

Chapter 10 System Security

Chapter 11 Configuration

Chapter 12 Calibrations

Chapter 13 GEM/SECS Option

Chapter 14 Wafer Stress Application Option

Chapter 15 CMP Analysis Algorithms

1

INTRODUCTION

INSTRUMENT OVERVIEW

The KLA-Tencor P-15 Profiler is a highly sensitive surface profiler that measures step height, roughness, and waviness on sample surfaces. Roughness can be measured with up to a 0.5 Å resolution over short distances. Waviness can be measured over the entire surface of a sample (assuming a sample size within the system's scan limits). The P-15 system uses stylus-based scanning to achieve high resolution and can correlate local submicron features with global surface measurements. It has a scan area of 200 X 200 mm.

The P15 system offers the option between three head configurations, each with a different vertical range: the MicroHead IIsr (standard range), MicroHead IIlf (low force), and the MicroHead xr (extended range).

- The **MicroHead IIsr** (standard range) has a vertical range of 327 µm and is capable of scanning at forces between 1 mg. and 50 mg.
- The **MicroHead IIlf** (low force) has a vertical range between 6.5 µm and 130 µm. It is capable of scanning with a stylus force between 0.05 and 50 mg. Low force is useful when scanning soft materials such as gold, indium, or photoresist.
- The **MicroHead IIxr** (extended range) extends the vertical range to 1000µm. It is capable of scanning at forces between 0.5 mg. and 50 mg.

The dual-view optics provide the user with an opportunity to view the sample from the top down and from the side. The top-down view is for accurate scan positioning. The side-view optics are used to view the stylus tip as it passes over sample attributes.

The P-15 is an automated surface scanner that can profile a wide range of topographies, including the following:

- CMP

  Recess measurement

  Large-feature dishing

  Pattern-dependant erosion

  Surface topography characterization

  Global planarity

- Data Storage

  Measurement of surface roughness

  Slider – pole-tip recession and texture bump characterization

CAPABILITIES AND PERFORMANCE

The Profiler software application runs in the Microsoft Windows environment. It offers the following capabilities and performance features. (See *Table 1.1*).

Table 1.1 *Capabilities and Performance*

Feature	Description
Microscopic and Macroscopic Feature Resolution	Combines macroscopic and microscopic surface analysis, and measures features as small as 0.25 µm.
Correlation Scanning	Provides a data reference for comparing the measurements of multiple microscopic features by re-scanning portions of a macroscopic long scan on the microscopic scale.
Die Grid Navigation	Offers an alternative method to that of positioning the sample by XY coordinates. Instead, it selects die location for measuring lithographic patterns in different dies.
Poletip Recession Analysis	Delivers nanometer-level accuracy in determining the height difference between the poletip and the airbearing surface by using the extremely flat scans of the P-15 systems.
Expandable Data Points	Guarantees that the horizontal resolution is limited by the stylus radius and not by the number of data points, by using a number of data points per profile. The number of data points is expandable up to 1 million (maximum).
Advanced Data Acquisition and Manipulation	Measures step height accurately on curved surfaces by being able to fit and level a scan. Automates data analysis relative to the feature by detecting the edge or apex of a profile feature. Measures many roughness and waviness parameters, with user-selectable cutoff filters to isolate roughness and waviness. Calculates statistics for multiple data sets (optional).
Data Recalculation Using different or additional scan parameters	Software versions 6.2 and newer save raw data from the scan for reanalysis of the scan. This allows the user to enter the original scan recipe and reset some of the scan parameters and then reanalyze the scan data using those parameters. Results can be saved in the database.
Database Management	Stores, manages, imports, and exports measurement recipes and scan data using a full-featured database manager.
Network-capable	Allows fast data transfers to a host computer, and can be networked to desktop computers. In addition, the optional SECS II Interface provides bi-directional communication between the instrument and a host computer.

HARDWARE FEATURES AND OPTIONS

Table 1.2 presents the P-15 system's hardware features and options.

Table 1.2 *Hardware Features*

Feature	Description
Dual-View Optics	All three head configurations offer dual-view optics. This provides Two distinct views of the scan surface. The first is a top-down view set of optics with two exchangeable lenses, 115-465x and 185-750x for fast, accurate positioning of the scan. The second is the side view optic set. The 90-410x optics provide the user a way to view the in-progress scan as the stylus moves over surface features.
Motorized Level and Rotation	Enables automatic mechanical leveling of the sample, and programmable sample rotation using a motorized rotary stage, enabling programmed θ-position repeatability of 4 µm (0.16 mil) at 4 in. from the center.
Vacuum Sample Hold-down	Secures a sample in the center of the stage.
Computer	Includes a 20-GB hard drive, and 256-MB RAM, and 52x speed CD-ROM. Also includes an Ethernet network adapter card, and a 3.5-in. floppy disk drive with 1.44-MB capacity. *Note: Computer specification subject to change.*
Monitor	Includes a 38.1-cm (15-in.) SVGA video monitor or 15-in. flat panel monitor that provides a magnified sample video image. *Note: Computer monitor specification subject to change.*
Keyboard	Includes a keyboard with a full set of standard AT keys, as well as some instrument-specific control keys. The keyboard has a trackball for fast cursor movement, stage, and measurement head motion control, and convenient menu option selection. The trackball and keyboard can be used interchangeably for these functions.
Printer Port	A parallel printer port is available for local printing.
Network-capable	Allows fast data transfers to a host computer, and can be networked to desktop computers. In addition, the optional SECS II Interface provides bi-directional communication between the instrument and a host computer.

Table 1.3 *P-15 Options*

Feature	Description
Desktop Program	Allows offline analysis and maintenance of scan data. This frees the profiler for measurement and allows the user to conveniently conduct data analysis in an office environment. The Desktop Program can be loaded onto a desktop or laptop PC running Windows.
Sequence Scanning	Automatically executes up to 600 sequential scans per sample by grouping scans into one sequence recipe file.
Pattern Recognition Software	Provides the system with the capability to perform pattern recognition of surface features used to quickly locate scan features on samples with multiple identical scan sites.
Enhanced **MaxView 3D™ Imaging**	Creates a photo-like presentation of sample topography. Its advanced manipulation and measurement tools provide the ability to better delineate and characterize surface features.
MicroHead IIIf Measurement Head	Low Force head, described in the Instrument Overview.
MicroHead IIxr Measurement Head	Extended Range head, described in the Instrument Overview.
Answer! Custom Software Macros	Extends the data analysis capabilities of the system.
Color Camera	Replaces the standard black and white camera. Not available with pattern recognition option. Factory installed only.
Color Printer	HP 950Cxi Printer w/cable, or equivalent model.
Stress Measurement	Measures and computes the average, maximum and center stress of surface films in MPa.
GEM/SECS Interface	SECS II Interface provides bi-directional communication between the instrument and a host computer.

2

BASIC SKILLS

OVERVIEW

Before beginning use of the P-15 system, it is important to become familiar with basic skills — such as starting and shutting down the system, and operating the system buttons, keyboard, trackball, Microsoft Windows , Profiler application, and other components.

This chapter describes:

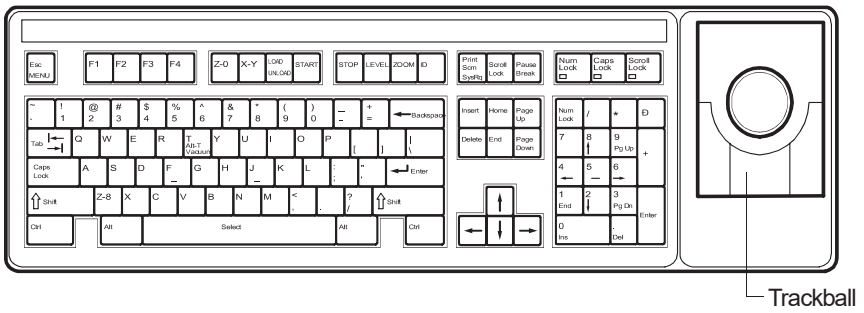
USING THE KEYBOARD

Introduction

The keyboard is an input device for communicating with the Profiler. The system interface and scan processes are viewed on the monitor.

Except where noted, the keyboard, the trackball, or a combination of both can be used to perform commands or enter data. (See *Figure 2.1*).

Figure 2.1 *Keyboard*



The keyboard is used to operate the instrument in functions such as entering parameters to establish the Profiler scan procedure, starting a scan, and transferring data files (importing and exporting data files).

1. To perform special functions, press the appropriate key(s) or the corresponding hot key(s). (See *Table 2.1*)

Table 2.1 *Keyboard Functions*

Key	Hot Key	Description
ESC	**ESC**	Closes the dialog box. Minimizes the menu, if a drop-down menu is displayed.
SHIFT-TAB		Puts text cursor in the previous field.
TAB		Puts text cursor in the next field.
PRINT SCRN	**CTRL+P**	Prints data from the current page.
DELETE		Deletes any characters in a data field.
ARROW KEYS [↑] [↓]		For menu items, they select the previous item (**UP ARROW**) or the next item (**DOWN ARROW**). Moves cursor up or down in text fields.

Table 2.1 *Keyboard Functions (Continued)*

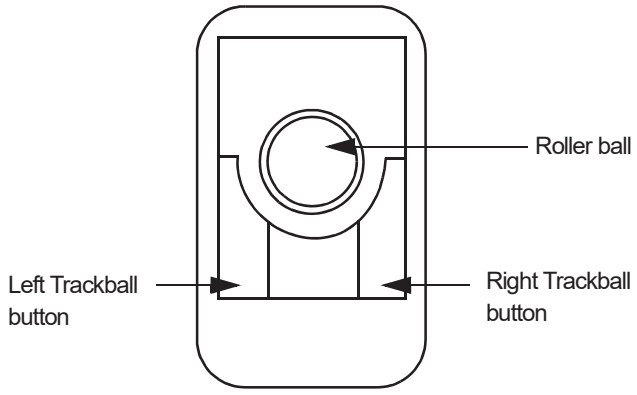
Key	Hot Key	Description
ARROW KEYS [←] [→]		Moves the measurement and leveling cursors left or right in the Analysis window. Selects the previous item (**LEFT ARROW**) or the next item (**RIGHT ARROW**) in a drop-down menu. Moves the cursor left or right in text fields.
ENTER		Launches currently selected icon. Selects menu item from drop-down menu. Completes the entry of any dialog. Same as clicking **OK**.
SPACEBAR		In the Analysis window, pressing the **SPACEBAR** activates first the right, then the left, then both cursors together (so they can move in tandem). Press again to repeat the cycle.
LEFT TRACKBALL BUTTON		See *Using the Trackball* on page 2-3 in the following section.
RIGHT TRACKBALL BUTTON		See *Using the Trackball* on page 2-3 in the following section.

USING THE TRACKBALL

Introduction

The trackball is a pointing device located on the right side of the keyboard. It consists of a motion-sensing mechanism (operating off the ball itself) and two buttons (left and right) situated around the trackball. (See *Figure 2.2*).

Figure 2.2 *Trackball*



By using the trackball to move the cursor to contact points on the screen and then clicking or double-clicking on the contact, commands can be executed. Examples are: starting software tasks, selecting commands from menus, entering data into the computer.

1. Use a gentle rolling motion of the trackball to move the cursor across the monitor screen.
2. Use one of the following actions with the left trackball button, as detailed in *Table 2.2*, to accomplish the required function.

Table 2.2 *Using the Left Trackball Button*

Action	Description
Click – To select an item or cancel a pending operation.	Press and release the left trackball button.
Double-click – To start an item.	Press and release the left trackball button twice in rapid succession.
Click and drag – To move an item from one location to another, or to select an item from a drop-down menu, or to select a section of text for editing, or to move scroll bars.	Press and hold the left trackball button while rolling the trackball. Release the trackball button when the desired function is complete.

POWERING UP THE PROFILER

Introduction

When powered up, the system proceeds to start Windows and Profiler applications, and initializes the Profiler equipment.

Power Up Procedure

1. Press the **ON/OFF** button on the monitor to activate the monitor.
2. Press the **ON/OFF** button on the Computer.

   The Computer starts, Windows is initiated, and the Program Manager is displayed.

SECURITY LOG ON

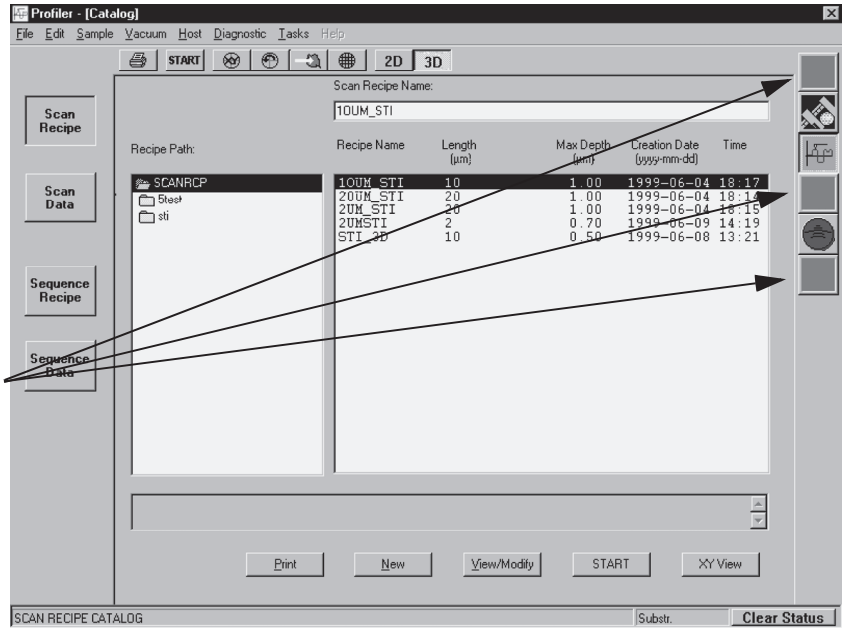
Introduction

The Windows system running the Profiler is designed to operate with a security log on procedure that limits access to various system function. This feature allows the system administrator to control access to system functions based on a log on password. Each user is assigned a log on word and a password that determines which functions are available to that user. In this way, the system is protected from users accidentally changing key parameters or accidentally erasing key data.

A user with limited access encounters system icons that are grayed out. (See *Figure 2.3*). This indicates that the functions represented by the icon are not available to that user. In other screens and windows, certain function buttons are grayed out. This means that the affected function is not available at that point in the procedure or that the user does not have access to that feature. Examples of button procedures with user access restrictions are some calibrations, data export, data import, and data manipulation.

Figure 2.3 *Catalog Screen With Some Access Denied*

When access to a function is denied due to the users logon privilege, the icon is grayed out to indicate restricted access. If the icons are grayed out, the function is currently unavailable. In this example, Configuration, Data Storage, and GEM/SECS are not available to the user.



Log On Procedure

A dialog box appears after the system is fully booted up. Use the following procedure to log on:

1. Press **CTRL-ALT-DEL** on the keyboard to display the Log on dialog box.
2. The cursor should be blinking in the Log on ID field. Enter the Log On word. **DO NOT CLICK OK**.
3. **TAB** to the **Password** field.
4. The cursor should be blinking in the **Password** field. Enter the Password.
5. Press the **Enter** key or click **OK**.

STARTING THE WINDOWS PROFILER APPLICATION

Introduction

The Windows Profiler application is the interface with the P-15 system from which the scan functions are performed and viewed.

Profiler Start-Up Procedure

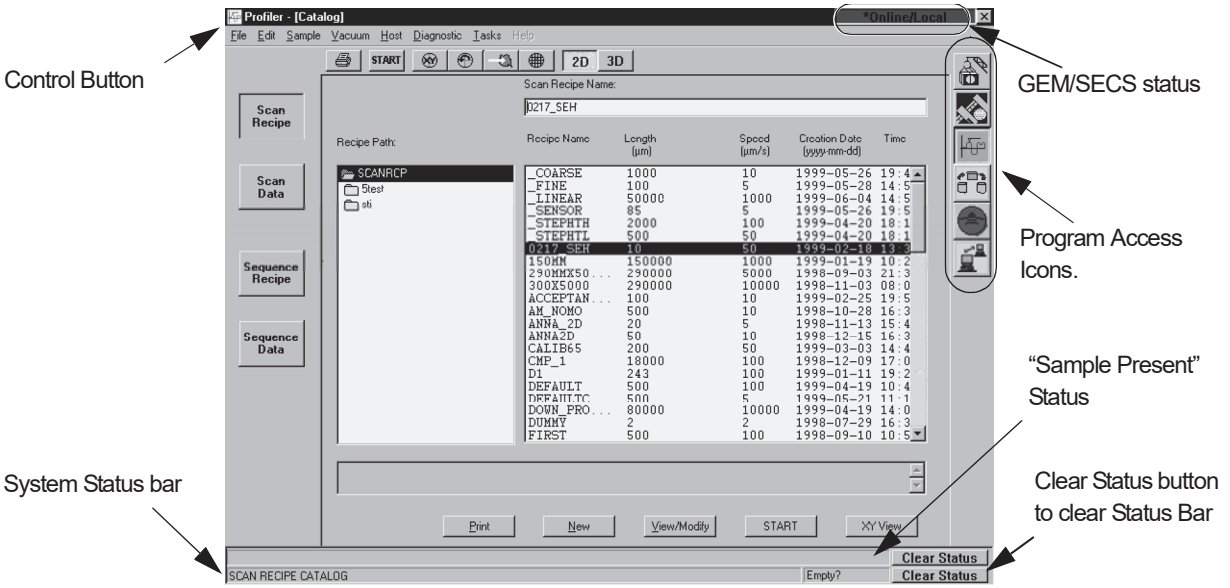
1. Use the trackball to locate the Profiler icon with the screen cursor. Double-click on the **Profiler** icon to initiate startup of the P-15 system (See *Figure 2.4*).

Figure 2.4 *Program Icons*

Step 1 When the boot cycle is complete and the log on is complete, double-click on the **Profiler** icon to initiate system start-up.

2. The system goes through its initiation at the end of which the **Profiler Catalog** screen appears. (See *Figure 2.5*)

Figure 2.5 *Profiler Catalog Screen*



This is the starting point for operating the instrument. In this screen, scan and sequence recipes can be accessed for system operation. This screen is also the entrance point for the other applications in the system. Each icon along the right side of the screen opens another application that contains the parameters or controls for a specific type of task. (See *Table 2.3*.)

Table 2.3 *Profiler Program Access Icons*

Icon	Description	Icon	Description
	**Configuration** Displays the Profiler Configuration screen. This screen provides access various configuration windows.		**Database File Manager** Displays the screen that provides access to files for export/import and delete.
	**Calibration** Displays the Profiler Calibration screen. This screen provides access to system calibration windows used for accessing various calibration procedures.		**Stress** Displays the Profiler Stress catalog screen. This screen contains access to the recipe and data file screens.
	**Scan** Displays the Profiler Catalog screen. This screen provides access to the Scan recipes, Sequence recipes, and data files.		**GEM/SECS** Displays the GEM/SECS screen. This screen is used to configure the system relationship with its host.

NAVIGATING BETWEEN PROGRAM LEVEL SCREENS

Introduction

The program level Profiler screens all have the program icons along the right border of the screen. These icons can be used to navigate between the various other program screens contained in the Profiler software.

Navigation Procedure

Use the following procedure to navigate between screens:

- Click on the icon of the required program screen. (See *Figure 2.6*.)

  This ***closes*** the current program screen and accesses the chosen one. This could generate a message box that inquires if changes to settings, or data are to be saved or discarded. Choose the required answer and follow any instruction.

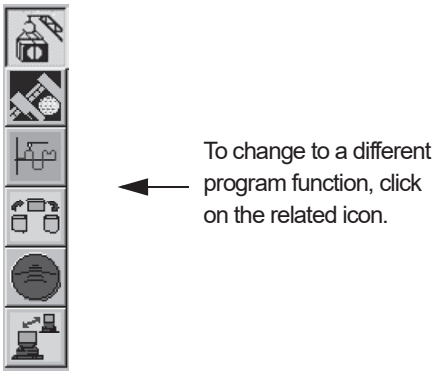
- Functions performed in some screens automatically access other screens.

  EXAMPLE:

  Performing a scan in the XY View screen generates the scan screen then the Analysis screen.

  The above screens do not contain the program icons. To change or exit, click **File** in the Menu Bar and choose **Exit** from the drop-down menu. In some cases it is necessary to click the control button at the top left corner of the screen and choose **Close** from its drop-down menu. This closes the current screen and displays the program screen from which the procedure was entered.

Figure 2.6 *Profiler Configuration Screen*



EXITING THE WINDOWS PROFILER APPLICATION

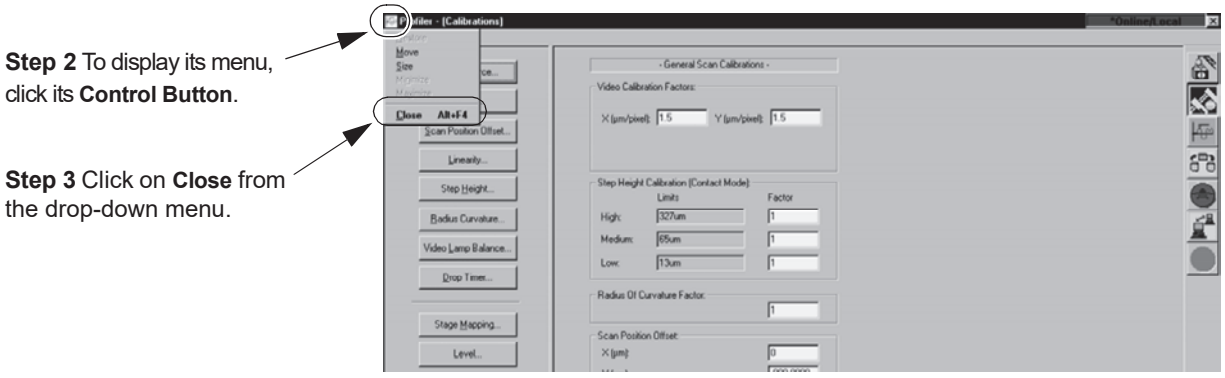
Introduction

This procedure is used to close the Profiler and Windows applications.

Profiler Exit Procedure

1. Close all screens up to a program screen (program level screens are represented by one of the program icons at the right side of the screen). (See *Figure 2.7*.)
2. Click on the control button at the top left of the screen to display the menu. (See *Figure 2.7*.)
3. Choose **Close** from the drop-down menu. (See *Figure 2.7*.)

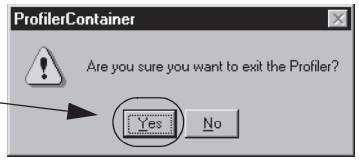
Figure 2.7 *Closing the Profiler Application Using the Control Button*



4. A Profiler Container (message box) appears asking, "Are you sure you want to exit the Profiler?" Click on **Yes** to exit. (See *Figure 2.8*.)

Figure 2.8 *Profiler Container for Profiler Shutdown*

Step 4 Click on **Yes** to exit the Profiler application.



To log off so another user can log on:

5. If exiting from the program so that another user can log on, click on the **Start** button at the bottom left of the screen to display its menu. (See *Figure 2.9*.)

Figure 2.9 *Start Menu*

Step 6 Click on **Shut Down** to display its dialog box.

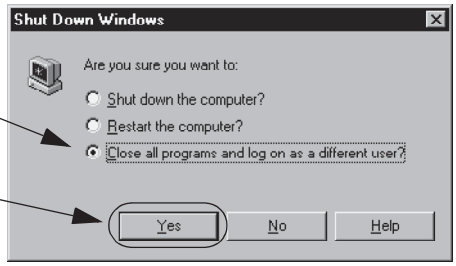
Step 5 Click on **Start** to display its menu.

6. Choose **Shut Down** from the menu. (See *Figure 2.9*.)
   This displays a dialog box that presents three options. (See *Figure 2.10*.)
7. Choose, **"Close all programs and log on as different user?"** by clicking in the radio button next to the question. (See *Figure 2.10*.)

Figure 2.10 *Shut Down Windows Dialog Box*

Step 7 Click on the radio button next to **Close all programs and log on as a different user?**

Step 8 Click on **Yes** to initiate the log off procedure and open the new log on.



8. Click **Yes** to log off and set up for another user to log on. (See *Figure 2.10*.)

POWERING DOWN THE PROFILER

Introduction

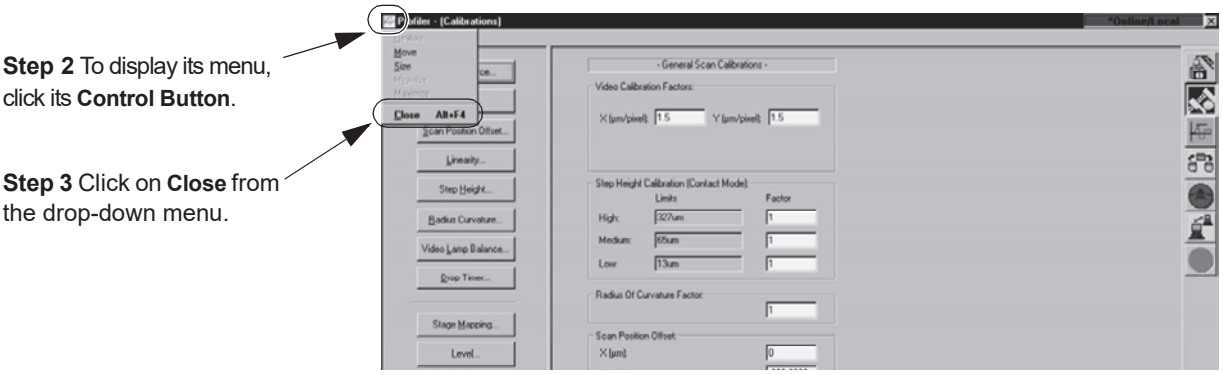
This procedure is used to power down the P-15 system.

This procedure is used any time the P-15 system must be completely shut down. (For example: for maintenance, repair, relocation of the instrument, or when system use is suspended for an extended period of time.)

Power Down Procedure

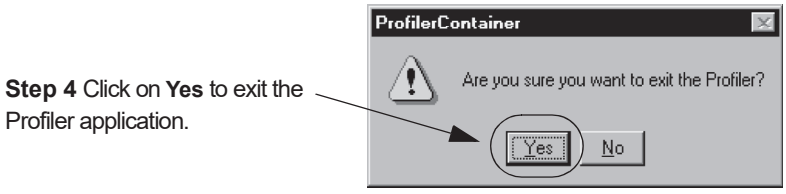
1. Close all screens up to a program screen (program level screens are represented by one of the program icons at the right side of the screen). (See *Figure 2.11*.)
2. Click on the control button at the top left of the screen to display it menu. (See *Figure 2.11*.)
3. Choose **Close** from the drop-down menu. (See *Figure 2.11*.)

Figure 2.11 *Closing the Profiler Application Using the Control Button*



4. A Profiler Container (message box) appears asking, "Are you sure you want to exit the Profiler?" Click on **Yes** to exit. (See *Figure 2.12*.)

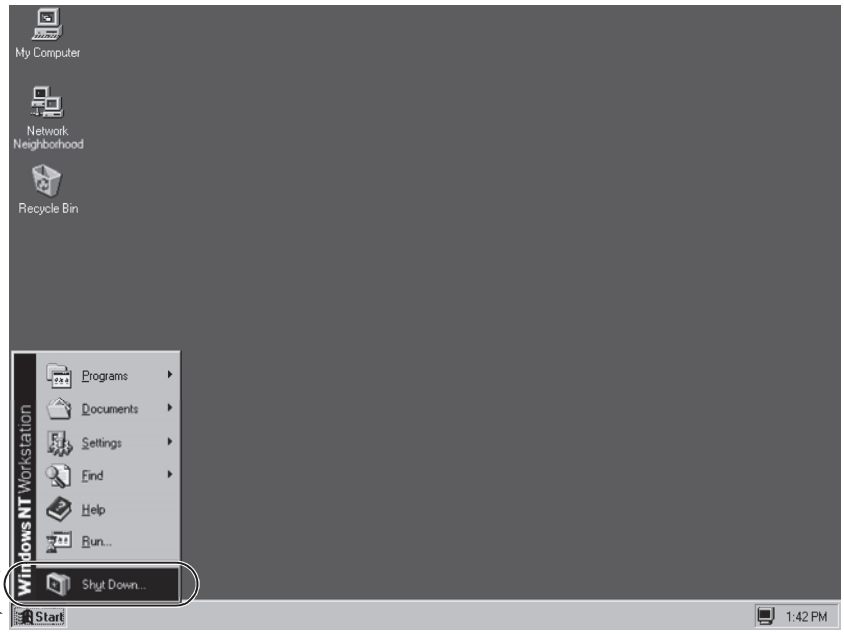
Figure 2.12 *Message Box for Profiler Shutdown*



To Log Off and Shut Down the System

5. If exiting from the program so that another user can log on, click on the **Start** button at the bottom left of the screen to display its menu. (See *Figure 2.13*.)

Figure 2.13 *Start Menu*

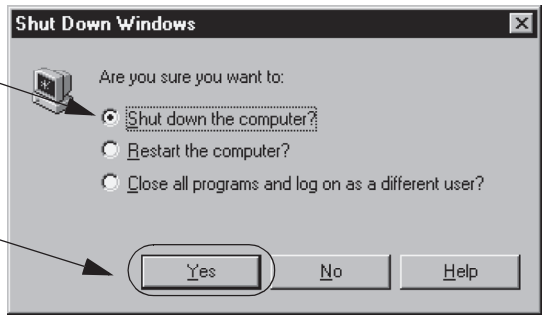


Step 6 Click on **Shut Down** to display its dialog box.

Step 5 Click on **Start** to display its menu.

6. Choose **Shut Down** from the menu. (See *Figure 2.13*.)
   This displays a dialog box that presents three options. (See *Figure 2.14*.)

Figure 2.14 *Shut Down Windows Dialog Box*



Step 7 To shut down the computer, click in the radio button next to **Shut down the computer?**

Step 8 Click **Yes** to initiate the shut down procedure for the computer.

7. Choose, "**Shut down the computer?**" (See *Figure 2.14*.)
8. After the computer has closed all applications and written information to the system drive, it displays a message box that says, "**It is now safe to shut down your computer.**"
   This message box has a button at the bottom of it that says "**Reboot?**"
9. If rebooting the system (without powering down the system) click on **Reboot?**

CAUTION: When the instrument is powered up or reset, the stage moves the Z axis all the way up, then X and Y to the 0,0 position.

10. If powering down the Profiler:
    a. Press the **On/Off** button on the Profiler computer.
    b. Press the **On/Off** button on the monitor to turn off the monitor.

Performing an Emergency Shutdown

The P-15 Profiler is powered up and shut down from the computer On/Off switch. In case of an emergency, turn off the computer and this shuts down the entire system.

Clearing a Diagnostic Message

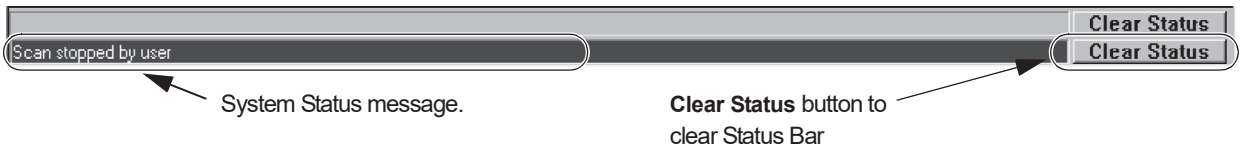
Introduction

Diagnostic messages appear in the status bar at the bottom of the window when an action or circumstances create the potential for instrument malfunction, such as occurs with a motion error. The system status bar also presents messages that guide the user through many of the system procedures. When a diagnostic message appears, the status bar at the bottom of the screen becomes red and the status bar must be cleared before it can display any new messages.

Clearing a Diagnostic Message Procedure

After reading the message in the status bar at the bottom left of the screen, click the **Clear Status** button on bottom right of the status bar to proceed. See *Figure 2.12*.

Figure 2.15 *Clearing the Status Diagnostic Messages*



PROTECTING THE STYLUS ARM ASSEMBLY

System Provisions for Stylus Protection

The P-15 profiler incorporate several design features that protect the stylus from damage. (See *Table 2.4*.)

Table 2.4 *Stylus Arm Assembly Protection*

Protection Name	Stylus Arm Protective Measure	Description of Result
Data Point Saturation	During an ascending scan, the scan is terminated when the stylus reaches its upper limit of travel (when it has pivoted up as high as it can go)	The stylus automatically retracts and the scan is terminated. In the Scan window, the trace ascends and flat lines at the top of its range.
Lowest Elevator Position	As a safety factor, the elevator can be programmed to lower only to a preset limit.	With the **Lowest Elevator Position** properly set, when the measurement head is lowered, it only goes as far as the setting allows, thus protecting the stylus and sample from damage. This setting is also used to trigger the head descent slow down point which occurs 1000 µm (set in the system registry) above the Lowest Elevator Position.
Proximity Sensor	The Proximity Sensor is designed to detect the sample as the head lowers and slow the descent.	With the Proximity Sensor **ON**, the head slows and stops as it nears the sample surface. If the Proximity Sensor is turned **OFF**, then the head descent slows when it reaches 1000 µm above the Lowest Elevator Position. The system then depends on the stylus contact with the sample surface to stop the head descent. If the stylus is coming down in a hole or off the edge of the sample, the system or the sample could be damaged by contact with the sensor assembly.

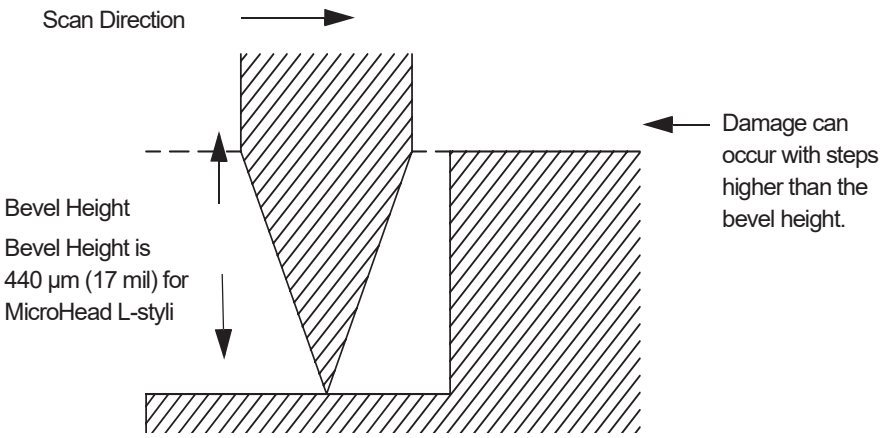
Potential Stylus Damage During Scans

Despite precautionary features, there are still circumstances where damage can occur.

- Damage occurs whenever the stylus is down and a vertical wall that is fixed to the stage moves against the stylus shaft.
- The stylus can be damaged whenever it encounters an obstacle higher than the bevel height of the stylus tip (higher than 440 µm (17 mils) for the MicroHead L-style stylus. (See *Figure 2.16*.)

- The stylus can be damaged by a shorter object if it has sharp corners or burrs that bite into the stylus tip.

Figure 2.16 *Contact Scan Stylus Tip*



- If the stylus is lowered or a scan is started when the sample is not directly under the stylus, damage to the stylus could occur.

  This is most likely to happen when lowering the measurement head such that the stylus drops into the center hole of a hard disk or misses the edge of the sample. Then when the stage is moved, the stylus is damaged.

CAUTION: Do not move the stage unless the stylus is well above the sample surface.

CAUTION: Do not start a scan unless the stylus is directly over the sample or damage to the stylus or head could occur.

- If a sample or precision locator is changed without resetting the **Lowest Elevator Position**, the head can lower onto the locator if the stylus misses the locator surface.
- Damage could occur when **MAN LOAD** is clicked, causing the sample or locator to hit the stylus. The measurement head must be at least 6.4 mm (0.25 in.) above the top of the precision locator.

NOTE: The stylus tip is located about 4 mm (165 mils) below the measurement head.

CAUTION: If changing the sample or precision locator to a different height, reset the **Lowest Elevator Position.** Otherwise, damage to the stylus or the measurement head can occur.

When designing custom jigs or fixtures, consider the precautions noted in this section. For instance, when designing a custom hard disk locator, its center section must be flush with the top of the disk surface. Care must be exercised when nulling where there is a hole in a jig, a vacuum hole, or a groove in a surface.

For hard disks only, when measuring the disk, avoid nulling in the Disk Locator hole.

NOTE: The KLA-Tencor Warranty Policy does not cover damage to the stylus arm assembly or the pivot caused by operator error or carelessness.

ADJUSTING THE VIDEO IMAGE

Introduction

The Video Controls allow the view of a particular sample surface to be optimized. The brightness and contrast can be varied for the camera.

NOTE: Changing the focus can invalidate sequences that use pattern recognition because the sample image is less likely to match the stored image in the pattern recognition files.

The purpose of adjusting the video image is to clarify the image resolution and contrast so it can be clearly viewed.

Video Image Adjustment Procedure

1. Open the **Scan Recipe** window. (Click on the **Scan Recipe** button in the Catalog screen. See *Figure 2.17*.)
2. Once the Scan Recipe window is active, with a recipe highlighted, click the **XY View** button to display the XY View screen. (See *Figure 2.17*.)

Figure 2.17 *Scan Recipe Window in the Catalog Screen*

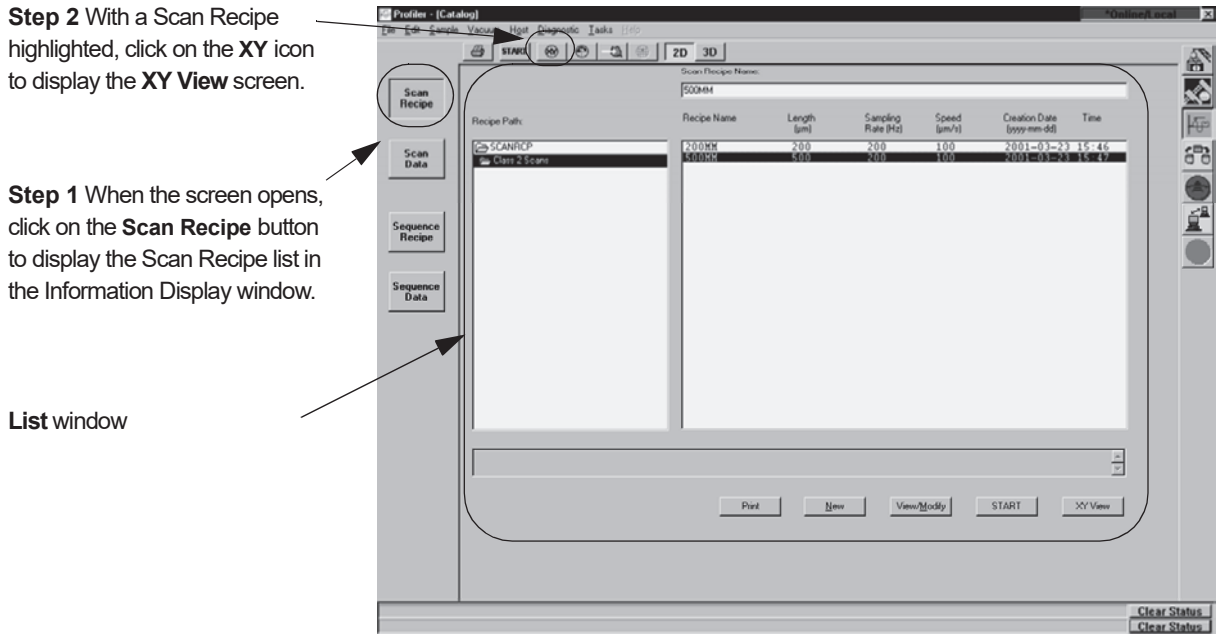
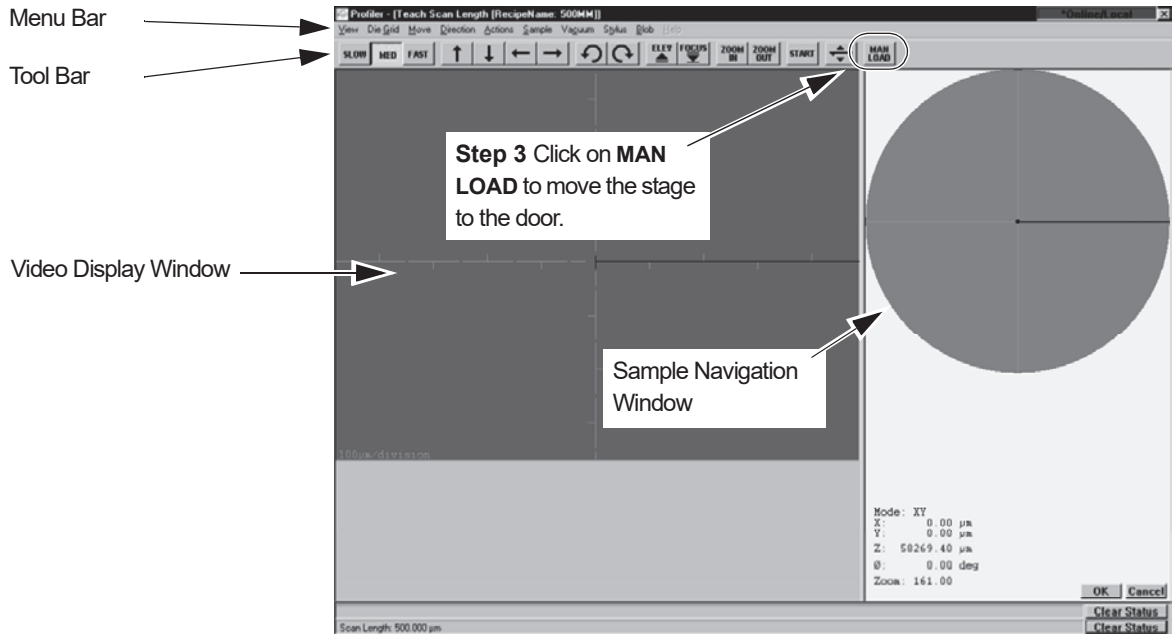


Figure 2.18 *XY View Screen*



3. Click on **MAN LOAD** (see *Figure 2.18*) in the Tool Bar to move the stage to the door. (See *Figure 2.18*.)

   The head rises to a taught height and the stage moves to the door (or the taught manual load position).

4. Open the door.

CAUTION: Do not open the door until the stage has completely stopped moving. All motors stop immediately when the door is opened. (Unless the interlock is disabled.)

5. Place the sample on the stage in the proper orientation.
6. Turn on the vacuum switch located on the left inside edge of the door.

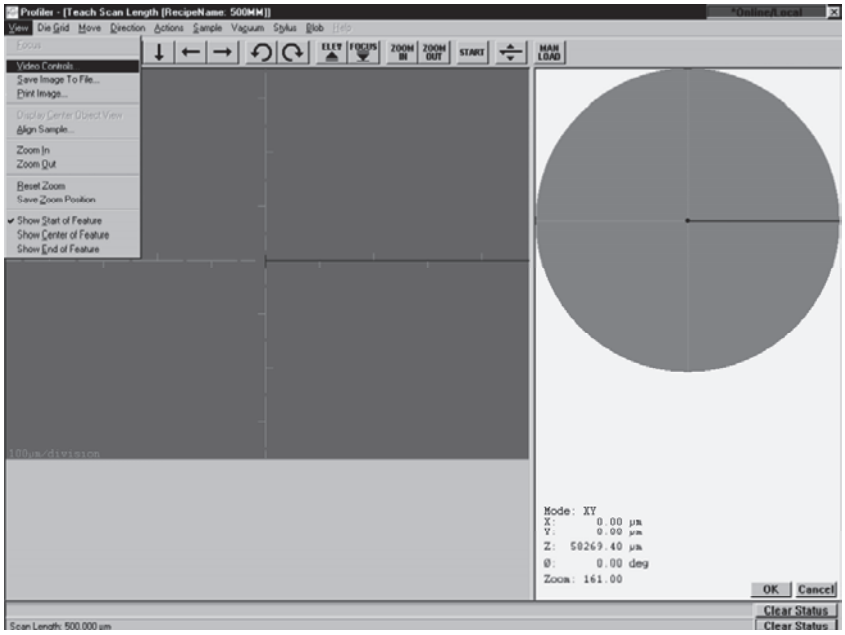
   The sample should now be securely in place on the stage.

7. Close the door.
8. Click on **MAN LOAD** to move the stage back under the system head.
9. Click the **FOCUS** button to null the stylus on the sample surface and focus at the chosen magnification. (See *Figure 2.18*.)
10. Click **View** in the Menu Bar to display its menu. (See *Figure 2.19*.)
11. Select **Video Controls**. (See *Figure 2.19*.)

Figure 2.19 *XY View Screen – View Menu*

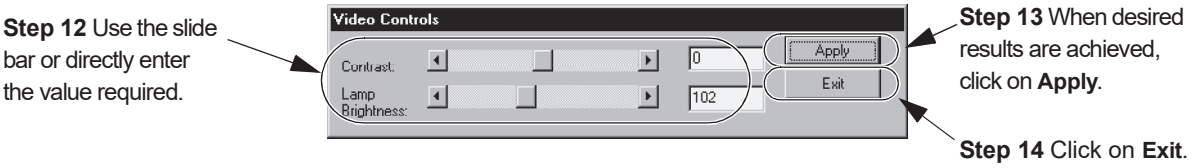
Step 10 Choose **View** from the Menu bar.

Step 11 Choose **Video Controls…** to display its dialog box.



The **Video Controls** dialog box appears. (See *Figure 2.20*.)

Figure 2.20 *Video Control Dialog Box*



12. Adjust contrast and brightness controls:
    a. Click and drag the slide bars for contrast and lamp brightness to achieve desired effect.
    b. If desired, type in the required values instead of dragging the slide bars.
    c. Repeat if needed until desired results are obtained.
13. When values for **Contrast** and **Lamp Brightness** are set, click **Apply.**
14. When the adjustments are complete, click **Exit**

    The settings are stored.

USING FILE NAME CONVENTIONS

Introduction

Scan and sequence recipes and data can be saved, as well as graphs and video images.

In the Windows naming convention only the following special characters are allowed:

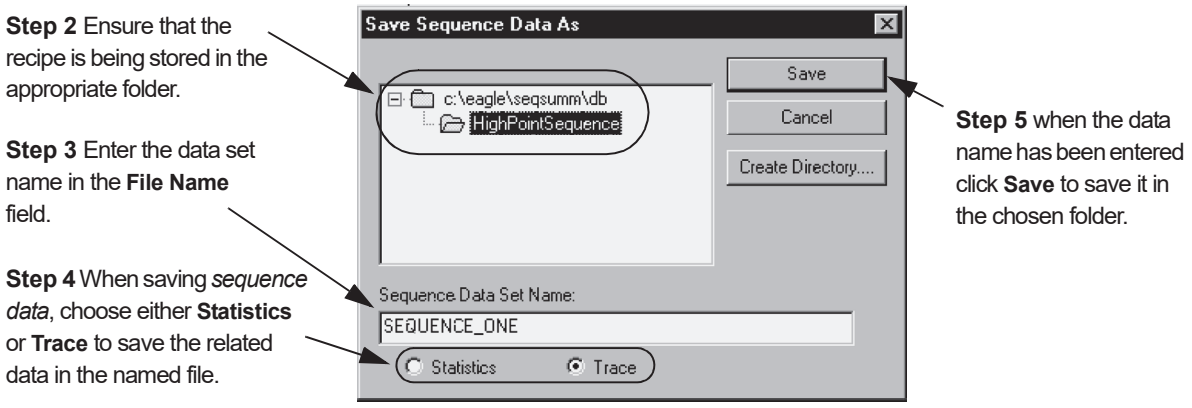
Table 2.5 *Special Characters Allowed for Naming Purposes*

◆ _ underscore	◆ - hyphen	◆ { left brace
◆ ! exclamation point	◆ & ampersand	◆ } right brace
◆ % percent sign	◆ (left parenthesis	◆ ‘ single quotation mark
◆ # number sign	◆) right parenthesis	◆ ' apostrophe
◆ $ dollar sign	◆	◆

Naming and Saving Files

1. When saving a file, click **File** to display its menu. Click the **Save...** button. A dialog box appears. The content and appearance differ slightly depending on what is being saved and the screen from which **Save...** was chosen. The one in *Figure 2.21* is for saving sequence data.

Figure 2.21 *Save Data Set Dialog Box*



2. Choose the appropriate folder in which to store the item being saved. (See *Figure 2.21*.)
3. Create a distinct file name for the item being saved. It is best to make the name representative of the content of the file if possible. The name can be up to 72 characters in length and should not contain empty spaces. Enter the file name in the file name field. (See *Figure 2.21*.)
4. Set any other necessary options required to properly store the information in the file. In *Figure 2.21* that would include setting the content format of the file to either **Statistics** or **Trace**, options only for sequence data. (See *Figure 2.21*.)
5. Click **Save** to save the data in the named file. (See *Figure 2.21*.)

SAVING VIDEO IMAGES

Introduction

A video image can be captured in the XY View window and saved to a file. Many standard image output file formats are supported.

Naming and Saving Video Images Procedure

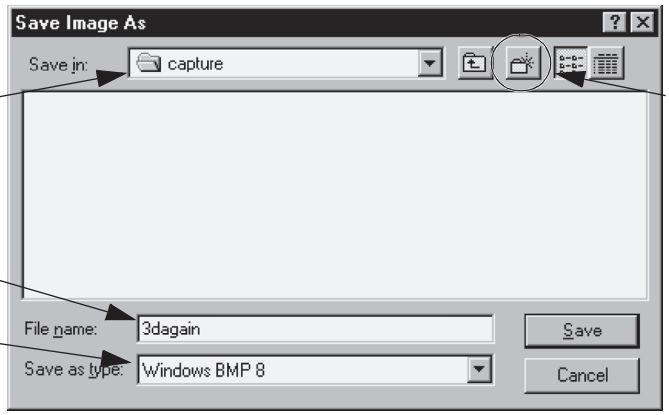
1. Go to either the **XY View** or **Theta View** window, and click the **View** menu, then select **Save Image to File** to display the **Save Image As** dialog box. (See *Figure 2.22*).

***Figure 2.22 Save Image As** Dialog Box*

Step 2 Choose a file to save the image in. Click on the menu-arrow, scroll until the directory or folder is found and click on it.

Step 3 Name the file that the image is to be saved as.

Step 4 Choose a format to store the image as. Click on the menu arrow, scroll until the format appears, click on the format.



Step 2 New folder. After choosing a directory for the file, click on this icon and enter a name for the new folder.

2. Choose the location in which the image is to be saved. To view the possible files, click on the menu-arrow next to **Save in** and click on the desired folder.

   To create another folder within a directory, click on the *new folder icon* and enter a name for the new folder.
3. Next to **File name**, enter a name for the image file that is to be created.
4. Set the format that the image is to be saved in:
   a. Click on the menu-arrow next to **Save as type:**
   b. Scroll until the desired format is visible.
   c. Click on the desired format.
5. Click **Save** to save the video image.
6. To view the video image, import the file into an application.

EXPORTING DATA GRAPHS

Introduction

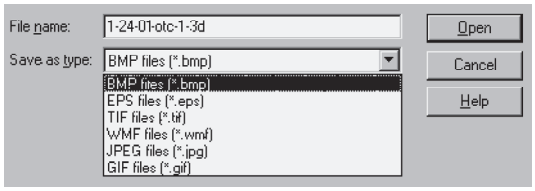
Data graphs are contained in the Scan Data catalog, Sequence Data catalog and in the Analysis screen when the scan data is being analyzed. 2D and 3D graphs can be exported directly from the Analysis screen during scan data analysis. 2D and 3D graphs from the Scan Data catalog can be exported in two ways: from the Analysis screen, and from the Database File Manager.

2D and 3D data graphs from the Sequence Data catalog can be exported only from the analysis screen because the file must be opened and the desired graph chosen and displayed before it can be exported.

The data graph is exported as a graphic image in one of the following file formats:

Bitmap format (*.bmp)	Encapsulated Post Script (*.eps)
TIFF format (*.tif)	JPEG format (*.jpg)
Word Metafile format (*.wmf)	GIF format (*.gif) (not supported)

Figure 2.23 *Export File Formats in Drop-Down Menu*



Exporting Data Graphs from the Analysis Screen

Opening the Export Graph Dialog Box from the Analysis Screen.

1. With the graph to be exported displayed in the Analysis screen, click **File** to display its menu. (See *Figure 2.24*.)

Figure 2.24 *Analysis Screen – File Menu*

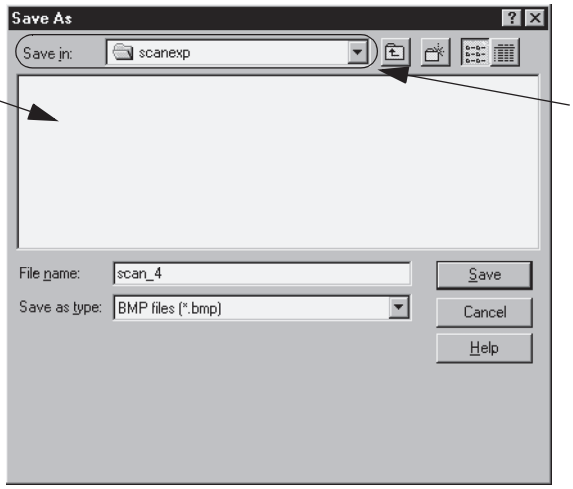
Step 1 Click on **File** to display its menu.

Step 2 Select **Export Graph** from the File menu.

2. Select **Export Graph...** (See *Figure 2.24*.)
   This displays the dialog box for graphic exports. (See *Figure 2.25*.)

Figure 2.25 *Export Graph Dialog Box*

This field contains any file tree that is directly under the folder in the Save In field above it.



If a graph is saved, it is placed in the folder that is displayed in the Save In field.

Step 3 Enter the file name in the **File name** field.

Step 4 When the file has been named, click on **Save** to save the newly named file in the folder displayed in the **Save In** field.

3. Set the required variables in the **Save As** dialog box. See *Table 2.6* for an explanation of the variables to be set.

Table 2.6 *Graphics Export Dialog Features*

Variable	Description
Save In:	This drop-down menu provides a *browse* feature from which to search for the folder that the graphic is to be exported to or the application that is to analyze it. The location must be and displayed in the **Save In:** field.
Save In: file tree field	Select the **Directory** path.
File Name	Type the **File Name**, up to 68 -characters in length.
Save as Type	From the drop-down menu, select the **graphic** format: (**BMP**, **TIFF**, **WMF, EPS,** or **JPEG)**.
Export Size (not visible from the Analysis screen)	The size options for the graph to be exported is not available in the Analysis screen because the operator can adjust the size of the image on the screen to the desired export size.

4. After all the information is entered, click **Save** to export the graph.

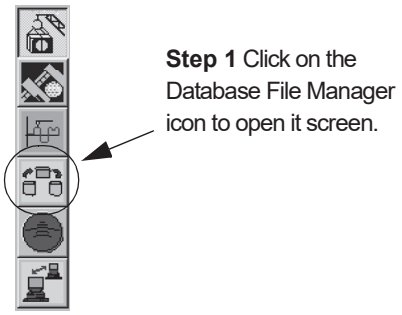
Exporting Graphs from the Scan Data Catalog

Exporting the Graph without Checking it in Analysis

Exporting Graph from the Database File Manager

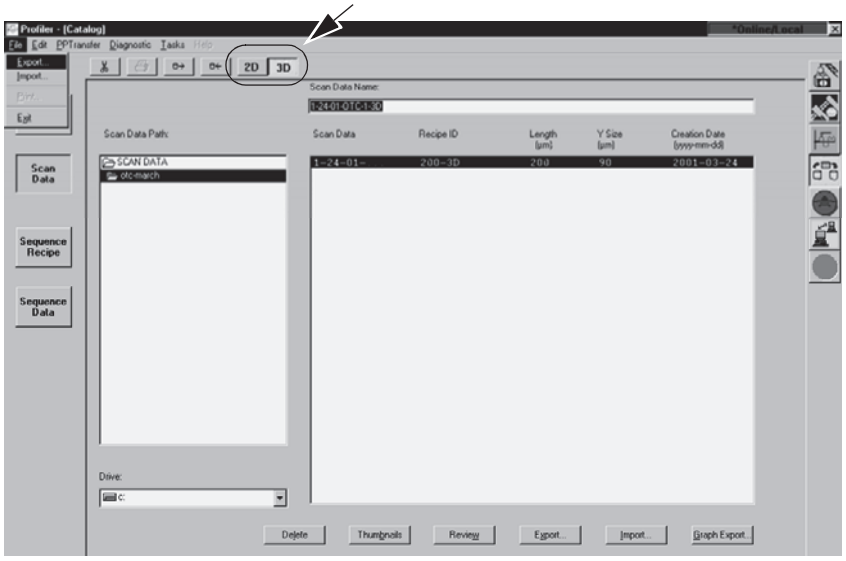
1. Go to any top level screen containing the system icons and click on the **Database File Manager** icon. (See *Figure 2.26*)

Figure 2.26 *Catalog Screen – Database File Manager Icon*



2. In the Database Catalog screen, choose either the **2D** or **3D** button in the tool bar. Depending on the Catalog group chosen, this displays the 2D or 3D data or recipe sets. (See *Figure 2.27*.)

Figure 2.27 *Data Catalog Screen for Export of Data or Recipes*



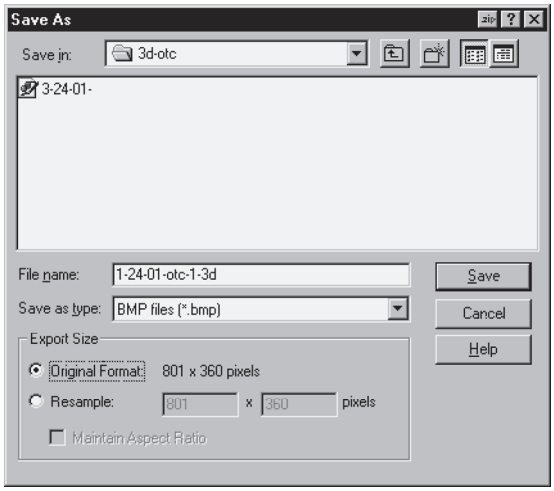
3. Choose **Scan Data** from the Catalog buttons at the left of the screen.
4. Navigate to the folder containing the required graph.

To Open the Export Dialog Box from the Database Screen

5. If the file name is known and there is no need to see the graph, click on the file name of the graph, and click on **Export Graph...** at the bottom of the screen.

This opens the export dialog box titled **Save As**. (See *Figure 2.28*).

Figure 2.28 *Graphics Export Dialog Box*



6. Complete the information in the dialog box. See *Table 2.7* for more information.

Table 2.7 *Graphics Export Dialog Features*

Feature	Description
Save In:	This drop-down menu provides a *browse* feature from which to search for the folder that the graphic is to be exported to, the application that is to analyze it, or the printer it is to be printed by. The location must be and displayed in the **Save In:** field.
Save In: file tree field	Select the **Directory** path.
File Name	Type the **File Name**, up to 68-characters in length.
Save as Type	Select the **graphic** format: (**BMP**, **TIFF**, **WMF, EPS,** or **JPEG**).
Export Size	Two options: **Original Format** and **Resample** *Original Format* – To export in the original format and size, click **Original Format**. *Resample* – To export in another size format, click **Resample** and use one of the following: ◆ Enter the scale sizes in pixels to change the sample size. (Note that if the numbers do not maintain the aspect ratio of the original sample, the graph is distorted.) OR ◆ To keep the same scale, enter the first size setting then click the **Maintain Aspect Ratio** checkbox. The system fills in the second number to keep the aspect ratio correct.

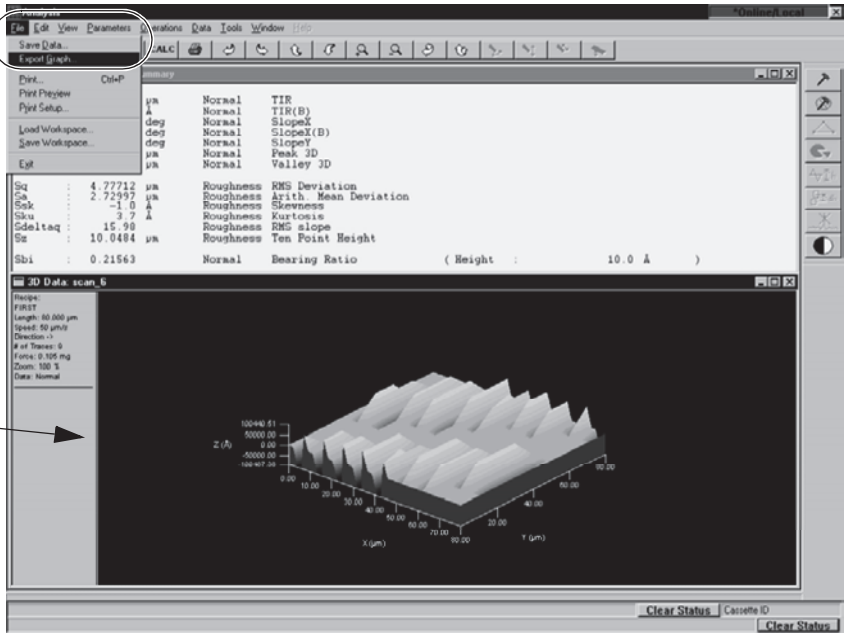
7. After all the information has been entered, click **Save** to complete the export.

Exporting the Graph After Checking it in Analysis

To Open the Export Dialog Box from the Analysis Screen

1. When the operator needs to see the scan graph before exporting it, after entering the Scan Data folder containing the scan file, double-click on the file. This opens the Analysis screen with the graph displayed.
2. If the correct graph is displayed, resize or reorient it as required before export.

Figure 2.29 *Scan Data Graph in the Analysis Screen*



3. Choose **Export Graph…** from the **File** menu (see *Figure 2.29*) to open the Save As (export) dialog box.
4. Fill in the required information. (See field explanations in *Table 2.8*.)

Table 2.8 *Graphics Export Dialog Features*

Variable	Description
Save In:	This drop-down menu provides a *browse* feature from which to search for the folder that the graphic is to be exported to or the application that is to analyze it. The location must be and displayed in the **Save In:** field.
Save In: file tree field	Select the **Directory** path.
File Name	Type the **File Name**, up to 72-characters in length.
Save as Type	From the drop-down menu, select the **graphic** format: (**BMP**, **TIFF**, **WMF, EPS,** or **JPEG**).
Export Size (not visible from the Analysis screen)	The size options offered in the Database screen for resizing the graph to be exported is not available in the Analysis screen. In Analysis the operator can adjust the size and orientation of the image on the screen before it is exported.

5. After all the information has been entered, click **Save** to complete the export.

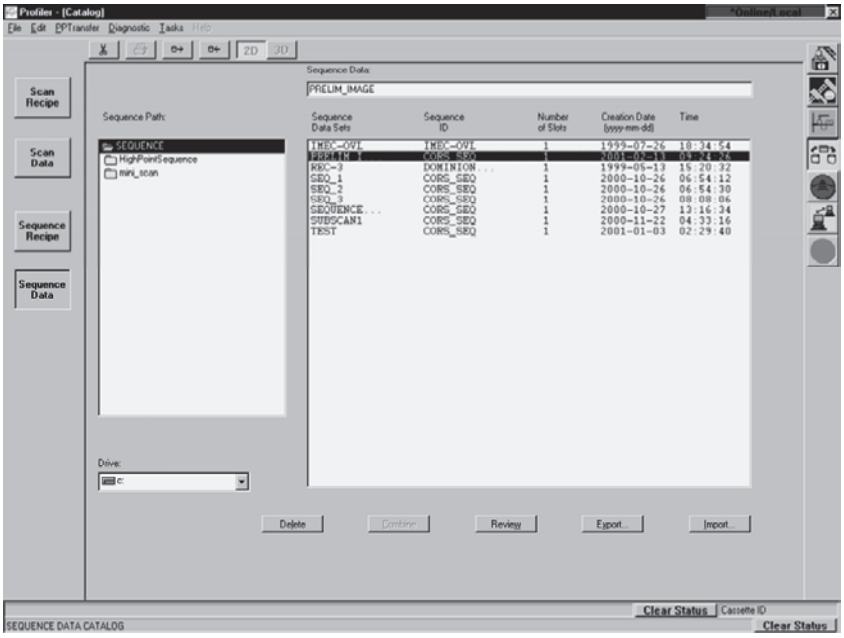
Exporting Graphs from the Sequence Data Catalog

The sequence file graphs cannot be directly viewed through the Sequence Data screen. The operator must open the data file in the Analysis screen and choose a specific scan graph to be exported.

1. From the Database screen, click the Sequence Data button to open the Sequence Data window in the Database screen.
2. Navigate to the folder containing the sequence data set that has the graph(s) to be exported.
3. To export a graph from a Sequence Data set, double-click on that sequence data set (see *Figure 2.30*) to open the Analysis screen with it displayed.

   The Analysis screen opens with the first scan from the first slot displayed in the Analysis window. To find the required scan graph it might be necessary to open the Surface Parameters Data (statistics) window.

Figure 2.30 *Choosing a Sequence Data Set*



4. If the Surface Parameter Data window is not open in the Analysis screen, click **STATS** to open it. (See *Figure 2.31*.) The Surface Parameters Data window can also be accessed by choosing **Surface Summary…** from the **View** menu.

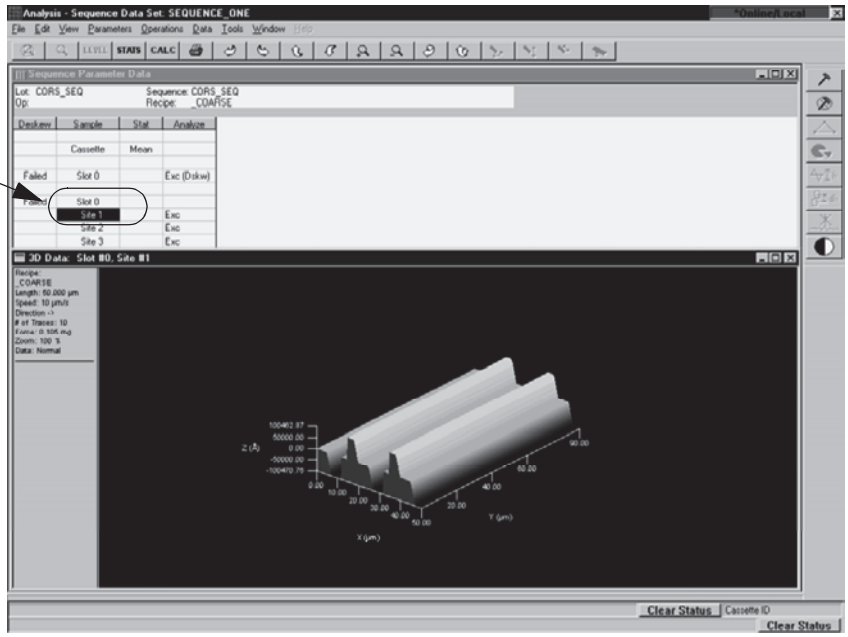
Figure 2.31 *Opening the Statistics Window to View Scan List*

Step 4 Click on **STATS** to open the Scan Parameters (Statistics) Window for viewing the list of scans in the sequence.

5. In the Surface Parameters Summary window, choose the required Slot and Site to display the scan that is to be exported. (See *Figure 2.32*.) The graph is displayed in the Analysis window.

Figure 2.32 *Surface Parameters Summary Window*

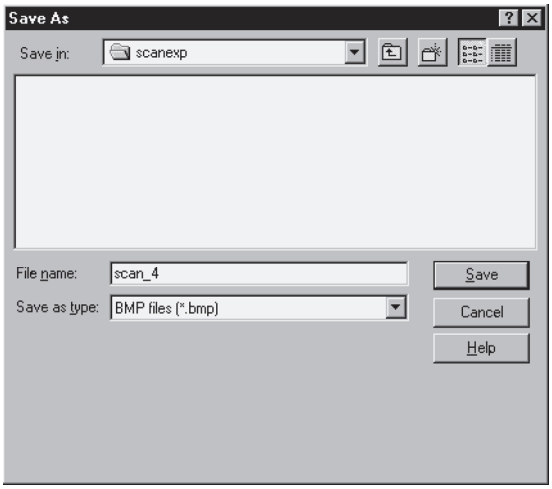
Step 5 Choose the Site to display the scan that is to be exported.



6. Resize or reorient the graph if necessary before being exported.

7. Choose **Export Graph…** from the **File** menu. This displays the **Save As** (export) dialog box. (See *Figure 2.33*.)

Figure 2.33 *Save As (Export) Dialog Box*



8. Set the options for the Graphics Export features. See *Table 2.9* for an explanation of the variables to be set.

Table 2.9 *Graphics Export Dialog Features*

Variable	Description
Save In:	This drop-down menu provides a *browse* feature from which to search for the folder that the graphic is to be exported to or the application that is to analyze it. The location must be and displayed in the **Save In:** field.
Save In: file tree field	Select the **Directory** path.
File Name	Type the **File Name**, up to 68-characters in length.
Save as Type	From the drop-down menu, select the **graphic** format: (**BMP**, **TIFF**, **WMF, EPS,** or **JPEG**).
Export Size (not visible from the Analysis screen)	The size options offered in the Database screen for resizing the graph to be exported is not available in the Analysis screen. In Analysis the operator can adjust the size and orientation of the image on the screen before it is exported.

9. Click **Save** to export the graph.

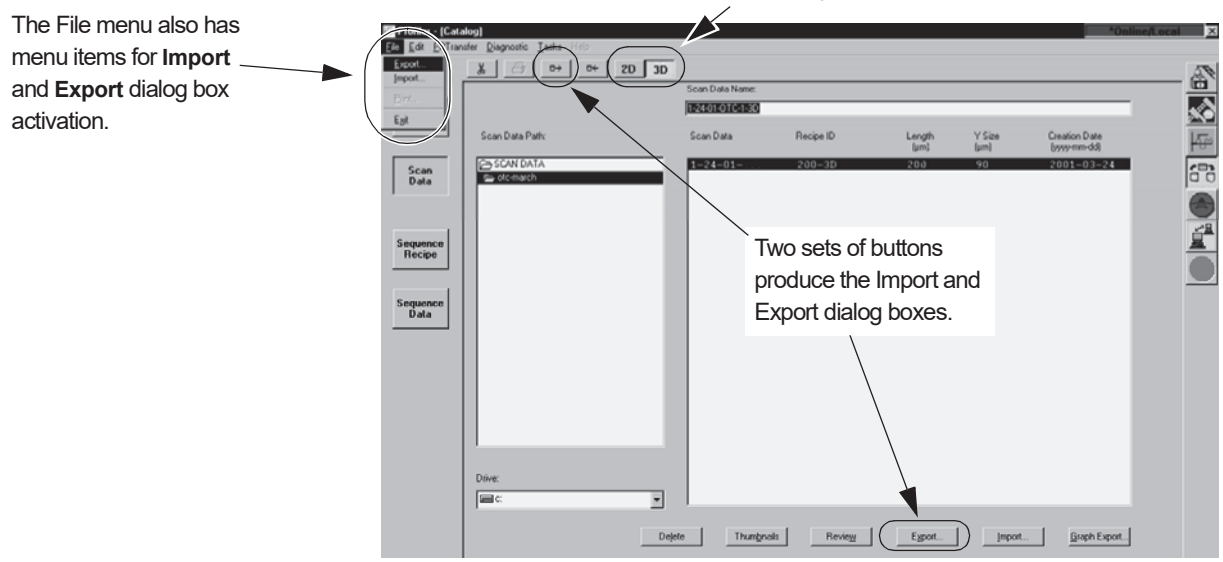
EXPORTING DATA FROM THE DATABASE FILE MANAGER

Export of data files from the Database File Manager is performed the same way for both Scan Data and Sequence Data sets.

1. From the Database File Manager choose either 2D or 3D files.

2. Choose either the Scan Data or Sequence Data catalog button. This displays the related 2D or 3D data files in the chosen catalog.

Figure 2.34 *Data Catalog Screen for Export of Data or Recipes*



3. Navigate to the required data set and click on it to highlight it.

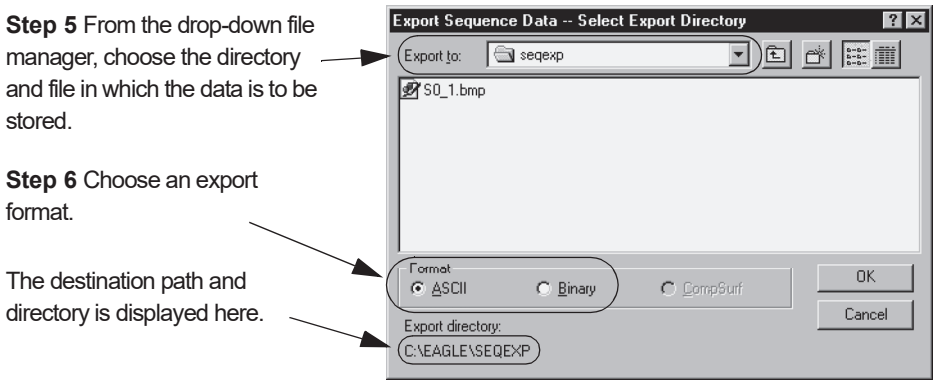
   There are three ways to access the **Export Sequence** (or **Scan**) **Data -- Select Export Directory** dialog box.

   - The **Export...** button at the bottom of the screen
   - The **Export Data** icon in the tool bar at the top of the screen
   - The **Export...** menu item in the **File** menu

4. Select **Export...** from one of its access points.

   This displays the **Export Sequence** (or **Scan**) **Data -- Select Export Directory** dialog box. (See *Figure 2.35*.)

Figure 2.35 *Export Data Dialog Box*



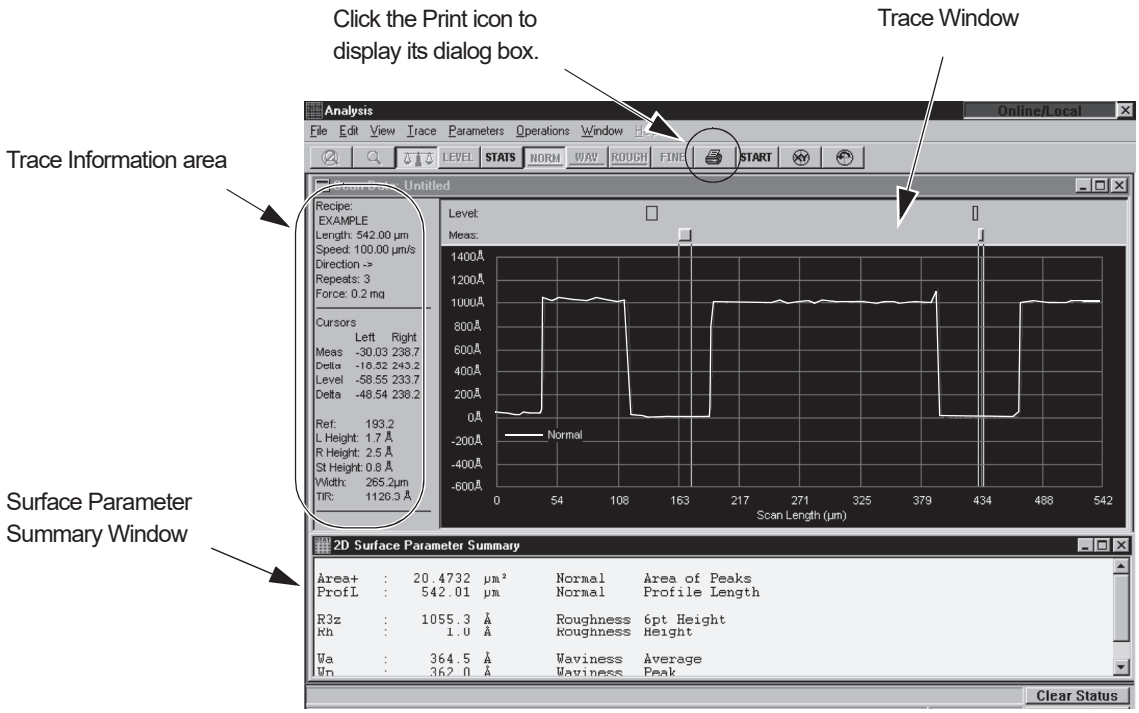
5. From the **Export to:** drop-down menu, choose the directory/folder that the data is to be exported to. The actual path and folder name are displayed at the bottom left of the dialog box. (See *Figure 2.35*.)
6. Choose an export format, either ASCI or Binary. (See *Figure 2.35*.)
7. Click **OK** to export the data to the destination folder.

PRINTING DATA

Introduction

When the scan is completed, the raw data is processed and displayed in the Analysis screen. (See *Figure 2.36*.) The Trace Information area, to the left of the trace, lists a summary of the trace data. Choosing **Surface Summary** from the **File** menu opens another window displaying calculated scan parameters, that can be pre-selected in the scan recipe.

Figure 2.36 *Analysis Screen*



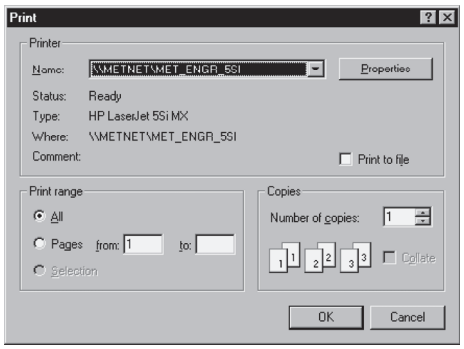
On the left side of the trace image is the Trace Information area.

- The Height text field displays the vertical distance between the trace intersections of the left and right measurement cursors.
- The Width text field displays the horizontal distance between the midpoints of the areas defined by the two cursors.
- Each cursor position and the stage position is displayed.

Print Procedure

1. Go to the **Analysis** window, and click the **Print** icon to display the Print dialog box. (See *Figure 2.37*.)

Figure 2.37 *Print Dialog Box*



2. Set the options for the **PRINT** features. (See *Table 2.10*).

Table 2.10 *Print Dialog Box Features*

Feature	Description
Print Range	Select the **Print Range** of pages (**All**, **Selection**, **Pages From _ To _**).
Properties	Select the **Print Quality** of text (**Low**, **Medium**, **High**).
Copies	Type the **Copies** number — to sort multiple copies, check the **Collate Copies** checkbox.

3. Click **OK** to print the data.

3

SCAN RECIPES

INTRODUCTION

The P-15 system performs scans of sample surfaces using recipes that set the parameters of each scan. Each recipe can be used alone or, if the system is capable of sequencing, in conjunction with other recipes in a sequence to gather necessary data from a given sample. Even some system calibrations use recipes to perform vital data gathering and analysis so the system can be calibrated for optimum performance.

The P-15 system is capable of high resolution scans in two or three dimensional formats. Both formats use trace data. The three dimensional scan uses a combination of parallel traces. The length of the traces, the distance between parallel traces, and the frequency of data point collection are all defined in the recipe. The two dimensional trace is a collection of data points made at a recipe specified frequency either as one trace, or a recipe specified number of traces over the same scan position, which are then averaged. The data is then presented in either a two or three dimensional graphical format for observation and analysis. Data storage and analysis are detailed in *Saving Scan Data* on page 8-47 and *Saving Scan Data* on page 9-45.

This chapter describes:

ACCESSING THE SCAN RECIPE CATALOG SCREEN

The Catalog screen is the first screen to appear when the profiler application is opened. The functional areas in the screen are described in *Figure 3.1* and *Figure 3.2*.

Figure 3.1 *Catalog Sequence Recipe Screen*

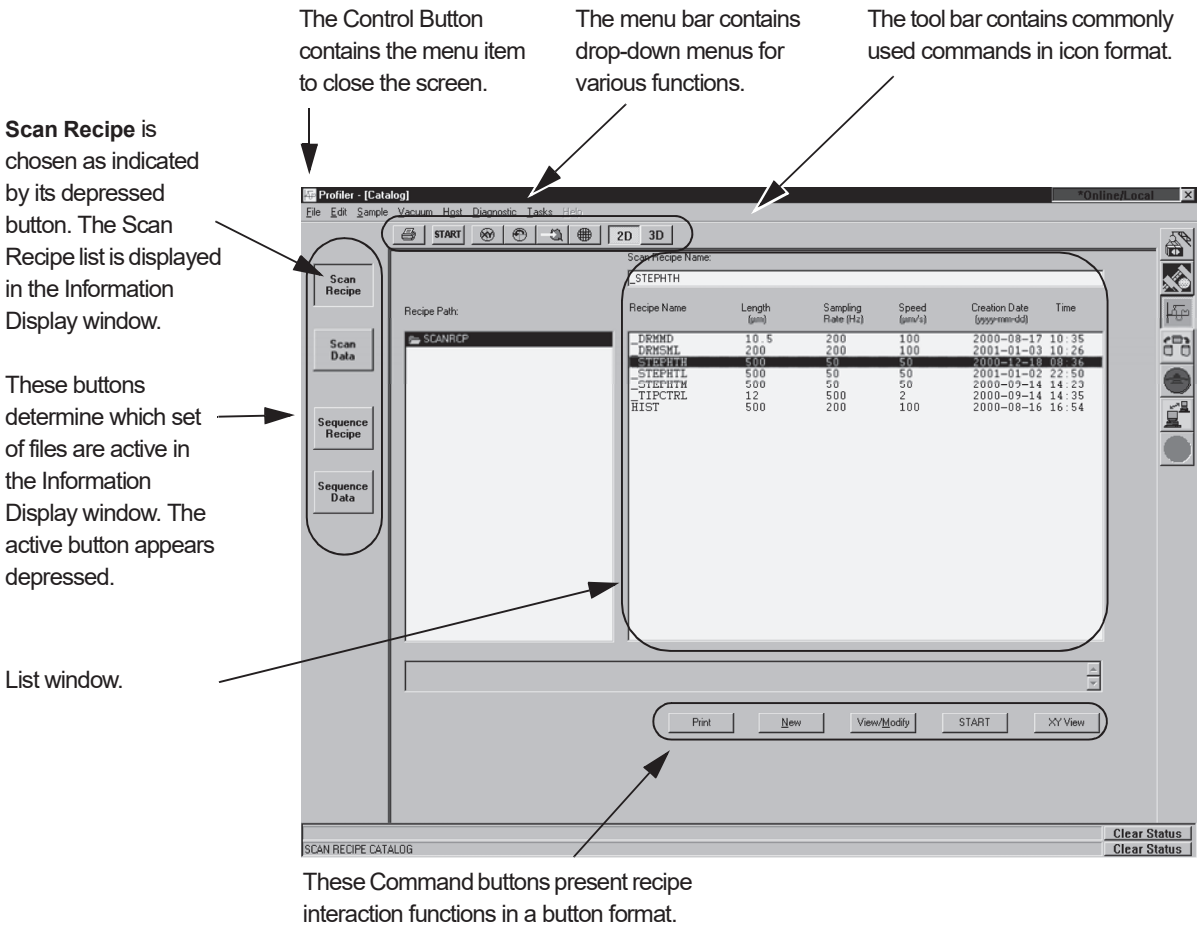
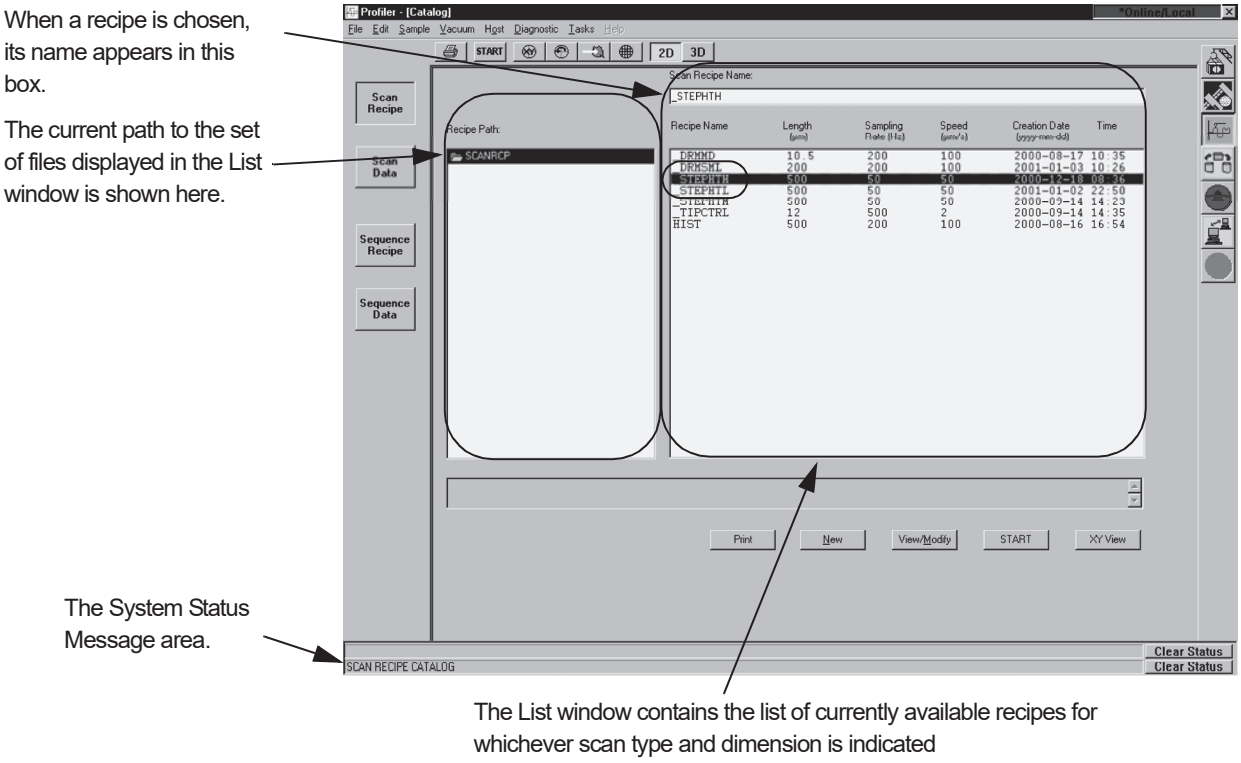


Figure 3.2 *Catalog Sequence Recipe Screen*



If the Scan Recipe button is not chosen, click on it. After the **Scan Recipe** button is clicked, the List window changes to the Scan Recipe list. The Scan Recipe screen is divided into functional **components**. Each is discussed in the following section, *Scan Recipe Catalog Screen Components* on page 3-3.

SCAN RECIPE CATALOG SCREEN COMPONENTS

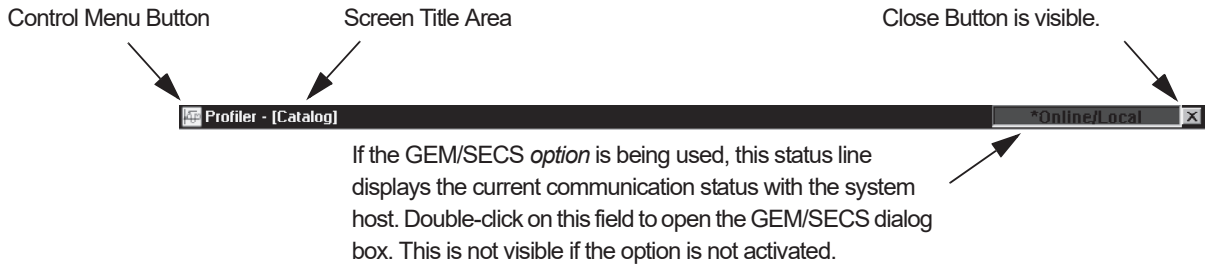
Screen Tools

The Catalog Screen Tools section is divided into three parts: Title Bar, Menu Bar, and the Tool Bar. An additional tool bar is located below the List window and is discussed in *List Window* on page 3-10.

Title Bar

The Title Bar contains the Control menu button, the Screen Title Bar, and the Close/Minimize icons or (See *Figure 3.3*) or the GEM Status for systems equipped with the GEM/SECS option.

Figure 3.3 *Title Bar for Catalog Screen*



- **Control Button**: This button is in the form of an icon that represents the currently displayed screen. (See *Figure 3.3*.) It is always in the same place but looks different depending on the screen currently displayed. Click on it to display its menu. (See *Figure 3.4*.)

Figure 3.4 *Control Button Menu*

The Control button menu contains the following options:

Table 3.1 *Control Button Menu*

Menu Option	Description	When Active/Inactive
Restore	N/A	Disabled to prevent interference with other screen operations.
Move	N/A	Disabled to prevent interference with other screen operations.
Size	N/A	Disabled to prevent interference with other screen operations.
Minimize	N/A	Disabled to prevent interference with other screen operations.
Maximize	N/A	Disabled to prevent interference with other screen operations.
Close	Closes the current screen (window).	Active in all screens.

- **Screen Title Area**: This identifies the current active screen. (See *Figure 3.3*.) It is not interactive.
- **Close:** This button is used to close the application. It is part of the Windows formatting. Do not use this button. Instead; use the **Menu Bar** or **Control Button** functions. If the **GEM Status** is displayed, the **Close Icon** might be covered. (See *Figure 3.3*.)
- **GEM/SECS Status Display (*for systems with the GEM option*):** This area displays the current GEM status. To view the **GEM Status** dialog box double-click on the **GEM Status Display**. (See *Figure 3.3*.) Settings in the dialog box should only be changed by those with a thorough knowledge of GEM/SECS functions in the system.

CAUTION: Only system engineers familiar with the GEM operation should change any settings in the GEM Status dialog box. Changing these settings could disrupt processing.

The following table presents the possible GEM Status messages and the significance of each message.

Table 3.2 *GEM Status Display*

GEM STATUS	Description
Online/Local	**Online** -The P-15 system is in the operating mode. **Local** - In this state, the P-15 system is controlling its own activity.
Online/Remote	**Online** -This P-15 system is in the operating mode. **Remote** - In this state, control of the P-15 system comes from the host.
GEM Offline	This means that the GEM communication link is suspended.
GEM Disabled	This means that the communication link is temporarily disabled for a user defined purpose.

Menu Bar

The **Menu Bars** (See *Figure 3.2*) have various drop-down menus for operating some of the system options available with the *current screen*. Each screen has its own menu bar with its own options and variables. Some of the options in the Menu Bar are also represented by icons in the **Tool Bar** and the **Command buttons**. The following tables present the content of each drop-down menu in the **Menu Bar** for the **Scan Recipe Catalog** screen.

NOTE: ne or more of the menu options in a given drop-down menu might be grayed out. This can be due to the permission status of the operator currently logged onto the system, it being an option that is not currently available because it requires other system options to be enabled before use, or the option's unavailability at this stage in the procedure.

***Figure 3.5 Menu Bar** for* **Scan Recipe** *Screen*

The Menu Bar for the Catalog screen contains seven active menus. Help is currently unavailable. Each menu is discussed in its own table. The Menu Bar menus are contained in *Table 3.3* through *Table 3.8*.

***Table 3.3 File** Menu Options Description*

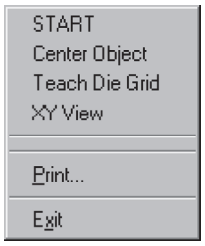
File Menu	Description	Function Access
	**START** Starts the currently highlighted scan procedure. The screen changes to the scan screen. In the screen depicted in *Figure 3.2*, it would start the **_STEPHTH** recipe scan.	Everyone has access.
	Center Object Displays the center object in the XY View Window.	Everyone has access.
	Teach Die Grid Opens the Teach Die Grid procedure in the XY View Screen.	Access Restricted: Permission Required
	XY view Brings up the XY View screen, which is the typical scan screen.	Everyone has access
	Print Brings up the Print Manager for printing recipes.	Everyone has access
	Exit Exits the Scan screen. This sometimes prompts the display of dialog box asking if the current changes are to be saved.	Everyone has access

***Table 3.4 Edit** Menu Options Description*

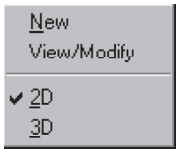
Edit Menu	Description	Function Access
	**New** This opens the Recipe Editor screen with an untitled recipe that is using the format of the highlighted recipe in the catalog screen. The recipe title is "UNTITLED" until the new recipe parameters are set and it is saved with a new name.	Access Restricted: Permission Required
	View/Modify This opens the Recipe Editor screen displaying the parameters of the recipe that is highlighted on the **Scan Recipe** screen.	Access Restricted: Permission Required
	2D This displays the 2D list of Scan Recipes in the Catalog display area. (See *Figure 3.2*.)	Everyone has access.
	3D This displays the 3D list of Scan Recipes in the Catalog display area. (See *Figure 3.2*.)	Everyone has access.

Table 3.5 *Sample Menu Options Description*

Sample Menu	Description	Function Access
	**Manual Load** This moves the sample stage to the Stage Door of the system (the manual load door) so a sample can be manually loaded onto the stage.	Everyone has access.
	Load/Unload Not functional in systems without a handler.	N/A
	Initialize Handler Not functional in systems without a handler.	N/A
	SMIF Load/Unload Not functional in systems without a handler.	N/A
	Initialize SMIF Not functional in systems without a handler.	N/A
	Release Cassette Not functional in systems without a handler.	N/A

Table 3.6 *Vacuum Menu Options Description*

Vacuum Menu	Description	Function Access
	**Off** This button is inactive in the P-15 because the Vacuum switch is manual.	N/A
	On This button is inactive in the P-15 because the Vacuum switch is manual.	N/A

Table 3.7 *Host Menu Options Description (Only available with GEM/SECS Option)*

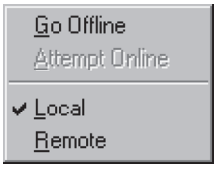
Host Menu	Description	Function Access
	**Go Offline** This takes the P-15 system offline. This is used to prevent the system from responding to a host during a user defined operation.	Access Restricted: Permission Required
	Attempt Online This attempts contact with the host to open the system communication link. The system then operates according to its predetermined GEM parameters.	Access Restricted: Permission Required
	Local This is an Online state where there is communication with the Host but in which the P-15 system controls the system's operation.	Access Restricted: Permission Required
	Remote This is an Online state where there is communication with the Host and in which the host controls the P-15 system operation.	Access Restricted: Permission Required

Table 3.8 *Diagnostics Menu Options Description*

Diagnostics Menu	Description	Function Access
Synthesize Data	Synthesize Data	Access Restricted: Permission Required

Table 3.9 *Task Menu Options Description*

Diagnostics Menu	Description	Function Access
Synthesize Data	Synthesize Data	Access Restricted: Permission Required

Tool Bar

The Tool Bar has eight icons that work as short cuts to functions.

Figure 3.6 *Tool Bar Icons*

The function of each icon is described in *Table 3.10*.

Table 3.10 *Tool Bar for the Scan Recipe Catalog Screen*

Tool Bar Icon	Description	Function Access
	Prints the currently highlighted recipe.	Everyone has access.

Table 3.10 *Tool Bar for the Scan Recipe Catalog Screen*

Tool Bar Icon	Description	Function Access
START	Starts a scan using the highlighted recipe in the List window.	Everyone has access.
	Switches to XY View screen with the current recipe active, ready for a scan to be run.	Everyone has access.
	Switches to the XY View screen with the stage rotation (theta) buttons active.	Everyone has access.
2D	Displays the following in the List window: ◆ 2D Scan Recipes, when in the **Scan Recipe Catalog** screen; ◆ 2D Sequence Recipes, when in the **Sequence Recipe Catalog** screen	Everyone has access.
3D	Displays the following in the List window: ◆ 3D Scan Recipes, when in the **Catalog Scan Recipe** screen; ◆ 3D Sequence Recipes, when in the **Catalog Sequence Recipe** screen.	Everyone has access.

Catalog Screen Access Buttons

The Catalog screen presents access to four sets of information. The Scan Recipe and the Sequence Recipe screen, provide access to the currently defined recipes available for execution in the P-15 system. Two data screens provide access to saved Sequence and Scan data file information.

Table 3.11 *Catalog Screen Access Buttons*

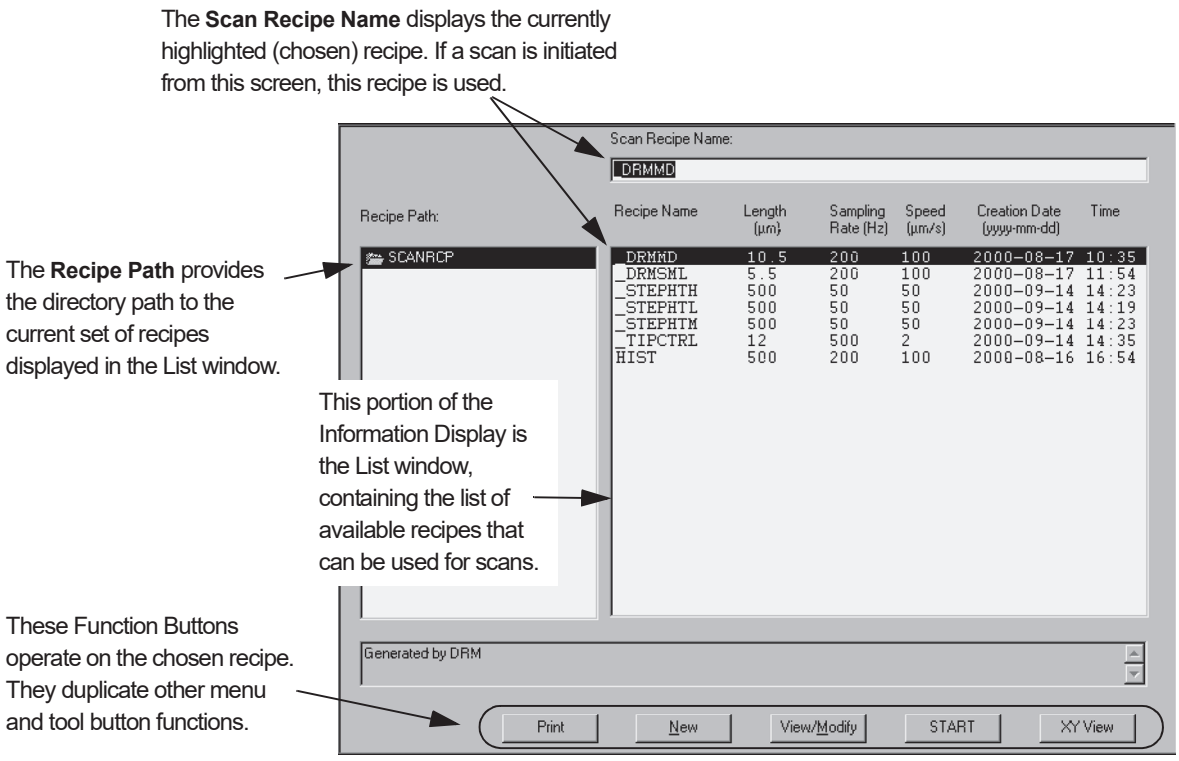
Tool Bar Icon	Description	Function Access
Scan Recipe	This button displays the list of currently available Scan Recipe folders, which when chosen, display their recipes in the Catalog screen's List window. (See *Figure 3.2*.)	Everyone has access.
Scan Data	This button displays the list of currently available Scan Data folders, which when chosen, display their data set in the Catalog screen's List window. (See *Figure 3.2*.)	Access Restricted: Permission Required
Sequence Recipe	*Optional* This button displays the list of currently available Sequence Recipe folders, which when chosen, present their recipes in the Catalog screen's List window. (See *Figure 3.2*.)	Everyone has access.
Sequence Data	*Optional* This button displays the list of currently available Sequence Data folders, which when chosen, present their data sets in the Catalog screen's List window. (See *Figure 3.2*.)	Access Restricted: Permission Required

List Window

List Window for Scan Recipe

When the **Scan Recipe** button is clicked, the List Window displays the Scan Recipe information and associated function buttons. (See *Figure 3.7*.)

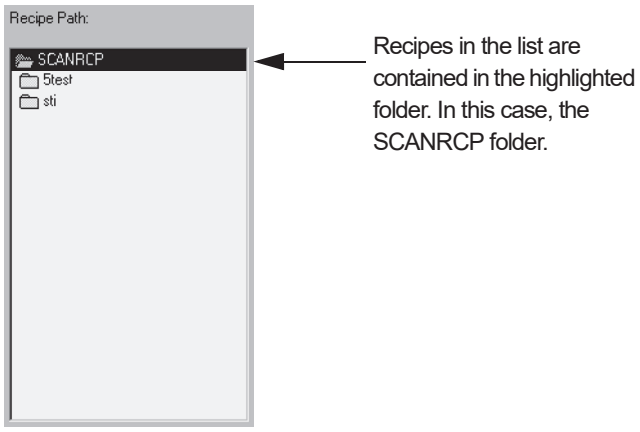
Figure 3.7 *Scan Recipe information in the List Window*



Recipe Path Display

This area is used for navigating to a particular folder of recipes in a directory. The recipes in the List window are contained in the highlighted folder in the Recipe Path display.

Figure 3.8 *Recipe Path Display*



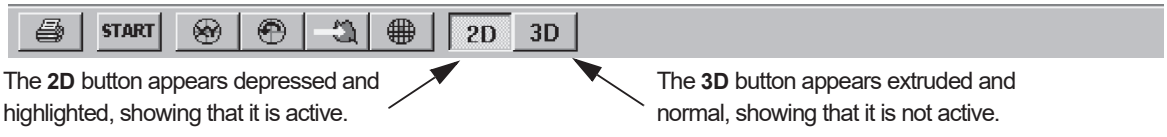
Scan Recipe Name Display

This field contains the name of the currently chosen scan recipe. The recipe is chosen by clicking on a recipe in the List window so that the recipe highlights. (See *Figure 3.7*.) The recipe in the **Scan Recipe Name** display is designated to be the *current* recipe. If the **START** button, at the bottom of the Information Display window (see *Figure 3.7*), or the **START** button in the Scan Recipe Catalog tool bar (see *Figure 3.6* and *Table 3.10*), is clicked, a scan is performed using the *current* recipe.

Recipe List Window

This area contains the list of scan recipes that have been created for the various types of scans used by the system. Scan Recipes are categorized into 2D Scan recipes and 3D Scan recipes. The recipes are accessible by clicking on either the 2D button or the 3D button in the tool bar at the top of the screen. (See *Figure 3.9*.) To determine which list is active, look at the 2D and 3D buttons. The active buttons appear to be depressed and highlighted. The inactive buttons appear extruded outward. (See *Figure 3.9*.)

Figure 3.9 *Tool Bar Buttons*



When a recipe in the current list is clicked on, it highlights and its name appears in the **Scan Recipe Name** display box at the top of the Information Display Window. In this state, when the **START** button in the tool bar (see *Figure 3.9* and *Table 3.10*.) or the **START** button among the function buttons at the bottom of the Information Display window (see *Figure 3.7*) is activated, a scan is performed using that recipe. In addition, the current recipe is featured in the Scan Recipe Editor screen that appears when the **View/Modify** button (a function button under the Information Display window) is activated. (See *Figure 3.7*.)

Function Buttons - Scan Recipe List Window

The function buttons, located at the bottom of the Information Display window, operate on the recipes in the recipe List window. Each button is active if it is not grayed out. The **Print**, **START**, and **XY View** buttons all duplicate functions available in a tool bar menu, and the Tool Bar. (See *Figure 3.9*.) The **New** and **View/Modify** buttons are duplicates of **Edit** menu options. (See *Table 3.4*.) If the button is not accessible, it appears as a 2D object, not 3D, and it is grayed out. Buttons might be inaccessible because:

- The system is operating in a Security level that does not grant the current Log On access permission to perform the corresponding function, or
- Because a preceding (or set-up) activity is required before the function can be activated.

Table 3.12 *Scan Recipe List Window Function Access Buttons*

Function Icon	Description	Function Access
Print	This prints the currently highlighted Recipe.	**Everyone has access**. This function is also performed by the **Printer icon** in the tool bar. 
New	This opens the Recipe Editor for the creation of a New recipe. In the recipe editor, the title is "UNTITLED" until the recipe is named. The recipe content contains the default parameters.	**Access Restricted: Permission Required**. The same function is also found in the **Edit** menu under **New**.
View/Modify	This opens the Recipe Editor allowing modification of the currently highlighted recipe.	**Access Restricted: Permission Required**. Same function is also found in the **Edit** menu under **View/Modify**.
START	This opens the XY View screen and begins the scan procedure associated with the currently highlighted scan recipe.	**Everyone has access.** This function is also performed by the **START** button in the Tool Bar at the top of the screen. 
XY View	This opens the XY View screen with the currently highlighted recipe in place to perform a scan.	**Everyone has access.** This function is also performed by the **XY** Icon in the Tool Bar. 

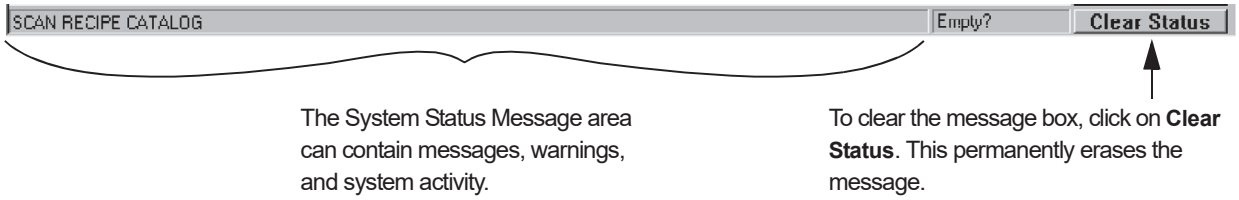
System Status Message

This portion of the screen contains current system status messages. These messages can contain any of the following:

- Instructions to the user.
- Warnings or Cautions
- Current system activity.

It is important to check this field for system information if the system appears to be stalled or inactive. This message field can contain valuable information for system troubleshooting.

Figure 3.10 *System Status Message Field*



CREATING AND EDITING A SCAN RECIPE

This section presents the procedure for creating a Scan Recipe. Included are:

- Accessing the Scan Recipe Editor where the recipe is created
- A description of the parameters required to create a recipe
- Naming the New Recipe
- Testing the New Recipe

Accessing the Scan Recipe Editor

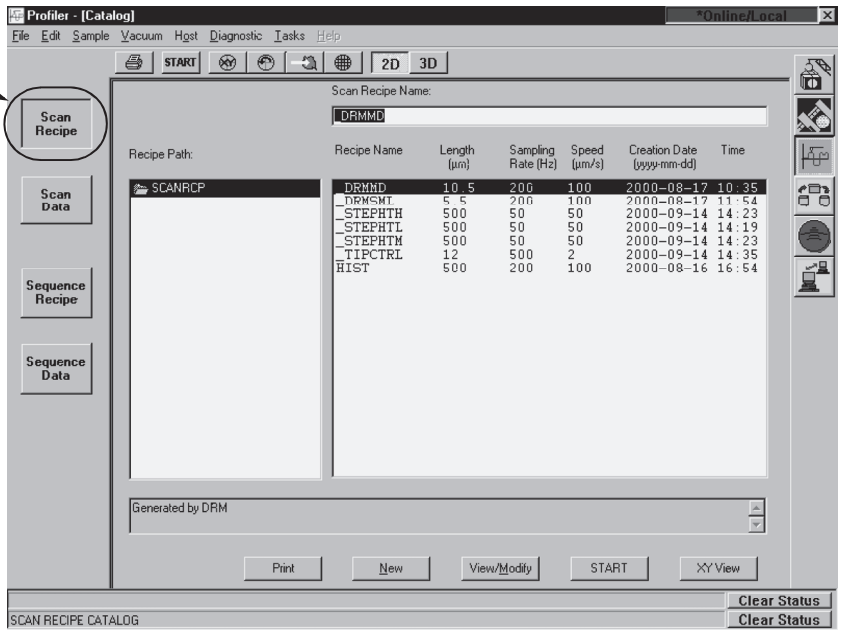
The actual creation of a scan recipe is performed in the Editor screen. This means that recipe creation and editing is restricted to those whose password permits access to the Recipe Editor. Use the following procedure to access the Recipe Editor screen:

1. Open the Profiler Catalog screen. (See *Figure 3.13*.)

2. Choose the **Scan Recipe** button to display the Scan Recipe catalog. (See *Figure 3.11*.)

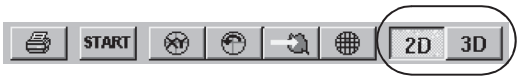
Figure 3.11 *Scan Recipe Catalog Screen*

Step 2 Click on **Scan Recipe** to display its contents in the Information Display window. The **Scan Recipe** button appears inset when its is chosen.



3. Choose 2D or 3D scan recipes by clicking on the appropriate icon. (See *Figure 3.12*.)

Figure 3.12 *Tool Bar*

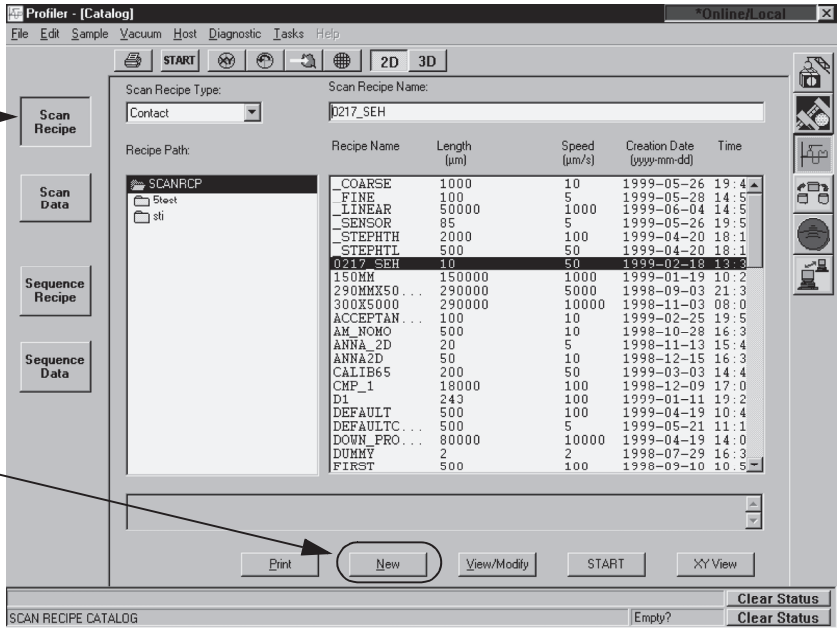


Step 3 Choose one of the dimension icons to display the list of associated recipes.

4. In the **Scan Recipe** list, a recipe is highlighted in the list. This has no effect on a **New** recipe. The new recipe is generated using default parameters. (See *Figure 3.13*.)

Figure 3.13 *Scan Recipe Catalog Screen*

When the **Scan Recipe** button appears inset, the Scan Recipe information is displayed in the List window.



Step 4 Click on **New** to display the Recipe Editor using the default values in the New recipe parameter.

Click on **New**, located among the function buttons at the bottom of the Information Display window. (See *Figure 3.13*.)

Recipe Editor for 2D and 3D Scans

Introduction

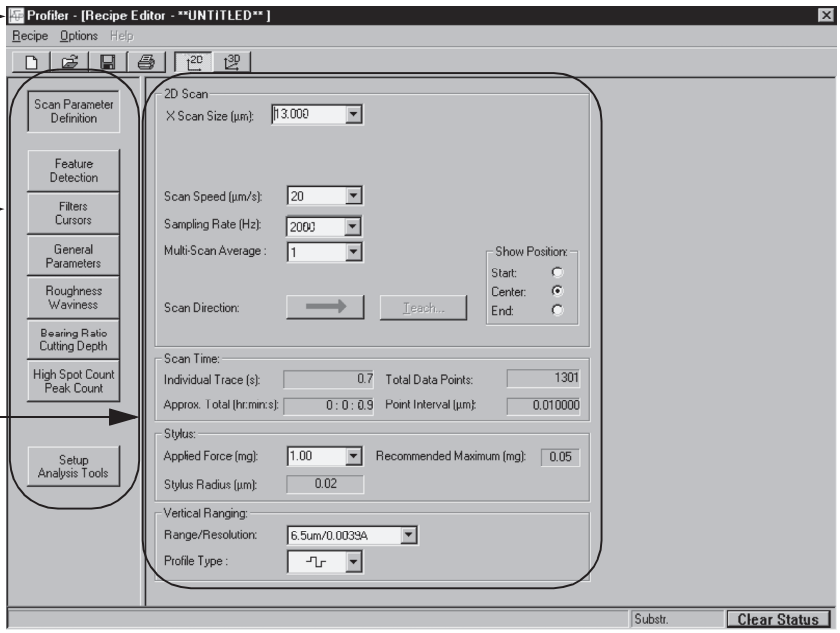
When **New** is clicked, the **Recipe Editor** appears with an UNTITLED recipe. (See *Figure 3.14*.) The UNTITLED recipe contains the default scan parameters. The **Recipe Editor** has eight windows for the 2D recipes and nine for the 3D recipes that, together, contain all the variable scan recipe parameters. Each of these windows is accessed through its own access button on the left side of the **Recipe Editor** Screen. (See *Figure 3.14*.) These windows are discussed one at a time, starting with the top button and working down, until all the parameters required for defining a recipe are explained.

Figure 3.14 *Recipe Editor for a 2D UNTITLED Recipe*

The Title bar shows that the recipe name is currently **UNTITLED** and the screen is **Recipe Editor**.

Each Parameter button displays its parameters in the Information Display window.

The Information Display window contains the parameter set related to the currently activated Parameter button. The current Parameter button appears to be indented, as the **Scan Parameter Definition** does in this illustration.



Scan Parameter Definition Window

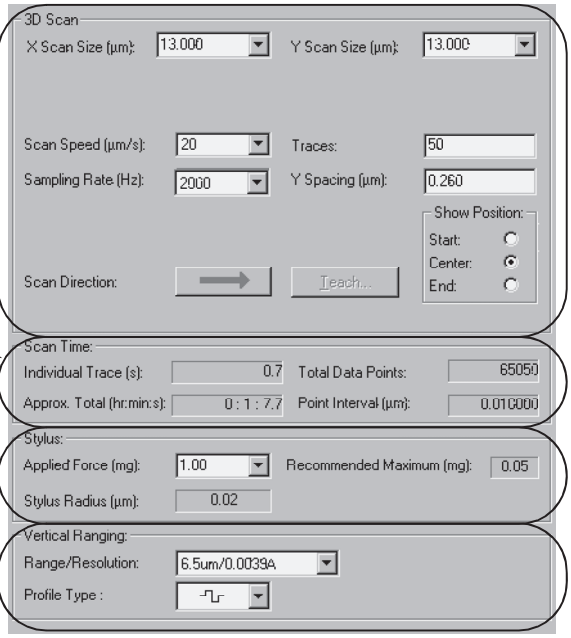
Figure 3.15 *3D Parameters in the Information Display Window*

3D Scan contains scan characteristics. (The 2D version contains fewer variables.)

Scan Time category contains parameters that are results of above actions.

Stylus category contains Stylus force and size parameters.

Vertical Ranging category contains vertical size (height, depth and scan profile of the scan.)

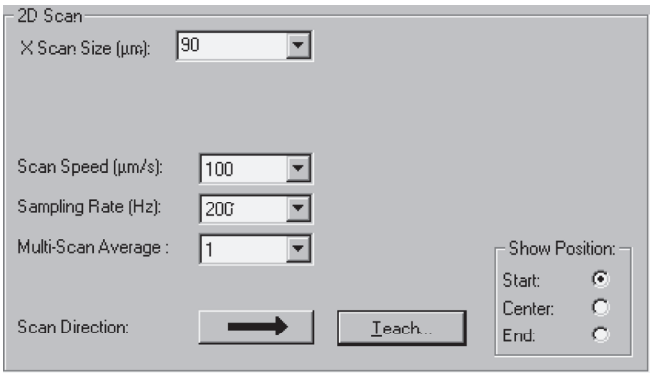


The **Scan Parameter Definition** button displays four categories of 2D or 3D scan parameters: **2D Scan** or **3D Scan**; **Scan Time**; **Stylus**; and **Vertical Ranging**.

2D Scan Category Parameters - Scan Parameters Definition

The parameters defined in this category deal with the actual mechanics of the 2D scan. Each is discussed in *Figure 3.16*.

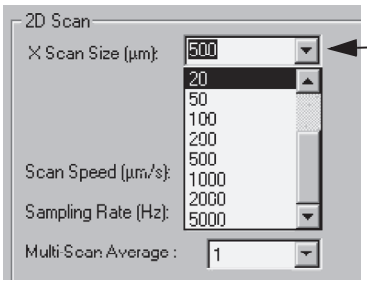
Figure 3.16 *2D Scan Category Parameters*



1. **X Scan Size (µm)**. This variable sets the **length** of the actual scan. It is set in one of two ways:
   - Click on the menu arrow at the right of the X Scan Size field to display the drop-down menu. Click on the desired number in the menu. The number should appear in the field. The variables in the drop-down menu range, in various increments, from 1 - 5000 µm. (See *Figure 3.17*.) For the *standard* P-15, 80000 µm is the longest possible scan. The *long scan* P-15 can scan 200000 µm.
   - Alternative: Double-click in the X Scan Size field to highlight the current number. Enter the desired number in microns (µm). This variable is helpful when a specific scan length is required that is not in the drop-down menu.

NOTE: The scan length can also be changed when using the Teach function. See Step *6. on page 3-22* for more details. See the Note.

Figure 3.17 *X Scan Size (µm)*

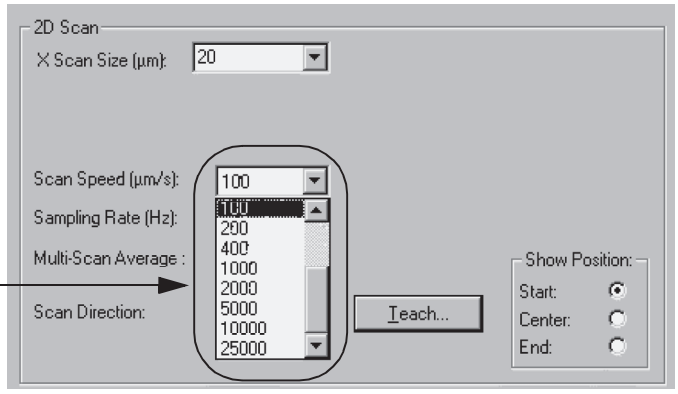


Step 1 Click on the menu arrow to display the drop-down menu. To choose the number of microns (µm) in the scan length, click on the appropriate number.

2. **Scan Speed (µm/s)** - This parameter sets the speed at which the scan is performed. It has a range between **1 µm/s** and **25000 µm/s**, with numerous options within this range displayed in its drop-down menu. (See *Figure 3.18*.)

Figure 3.18 *Scan Speed Drop-down Menu*

To set the Scan Speed, click on the menu arrow in the **Scan Speed** field and click on the desired speed.



The Scan Speed should be determined in conjunction with the stylus tip size and the **Applied Force** setting. *Table 3.13* lists some recommended safe scan speeds for operation of the P-15 systems. Following the guidelines in the table should protect the stylus tip and the sample:

Table 3.13 *Recommended Scan Speeds*

Stylus Tip Size	Applied Force	Scan Speed	Related Condition
Submicron Tips	0.05 - 0.10 mg.	Not to exceed 10 µm/s	Soft materials*
2 µm Tip	0.5 mg.	2.0 - 10 µm/s	Soft materials*
2 µm Tip	1 - 2 mg.	Not to exceed 200 µm/s	Normal scans

*Soft Materials - such as copper, gold, aluminum, and photoresist

The following cautions are important in determining a safe scan speed.

CAUTION: When scanning soft material (e.g., copper, aluminum, and photoresist) follow the recommended applied force and scan speed for each listed stylus.

CAUTION: If the scan speed is set too fast when using a small applied force, features might be missed or inaccurately traced.

3. **Sampling Rate (Hz)** - is the frequency at which data points are collected. (It sets the number of data points that are collected per second during a scan.) Optimum data collection is determined by this number in conjunction with the scan speed, the length of the scan, and the size of the stylus tip. The Sampling Rate should be set so that each data point has meaning. In general, as the scan progresses, the Sampling Rate should not calculate out to be greater than 1/4 the radius of the

stylus tip. Any more than that reduces the significance of each data point. (See *Figure 3.21* and *Figure 3.22*.) Collecting more data points does not necessarily improve the accuracy of the scan results and can cause slower system calculations (as could be the case when using Multi-Scan averaging with an unnecessarily high Sampling Rate). (See the example below.)

EXAMPLE: The following demonstrates the relation between scan speed, scan length, and Sampling Rate:

- Scan Speed = 10 µm/s Scan Length = 100 µm
- Sampling Rate = 20 Hz Stylus radius = 2 µm

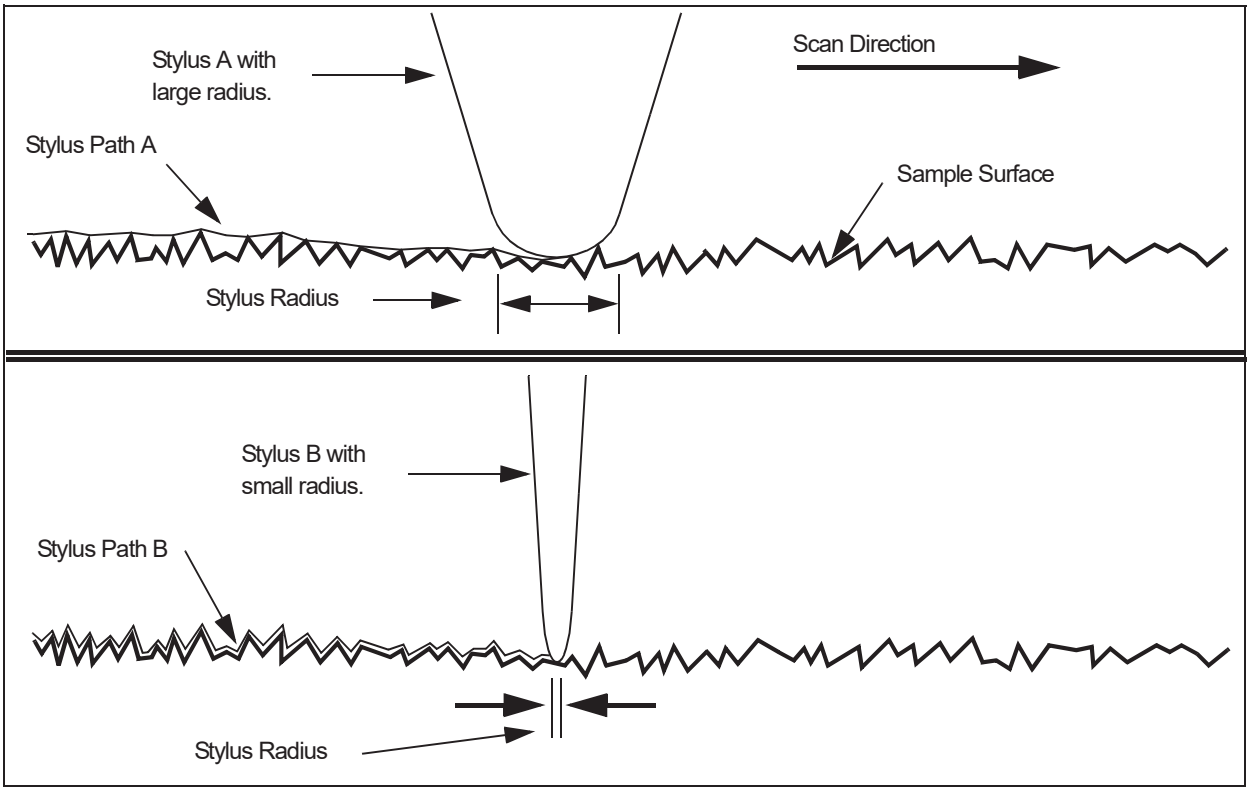
  20 data points are collected each second during a 10 second scan (20 Hz.)

  200 data points are collected during the total scan.

  200 data points over a 100 µm scan means that 2 data points were collected per micron during the scan.

Figure 3.19 illustrates the impact of stylus radius in generating a scan trace.

Figure 3.19 *Scan Trace Comparison - Large vs. Small Stylus Radius*



Comparing the Scan Path of the large radius stylus and the small radius stylus, assessment can be made regarding the validity of higher frequency data collection. In general, the larger radius styli do not detect the smallest features. They give traces that can resemble a statistical average. Little is gained by increasing the number of data points collected during a large radius stylus scan, if the stylus is not capable of capturing the smallest surface features. (See *Figure 3.19* and *Figure 3.21*.)

Figure 3.20 *Data Collection Frequency*

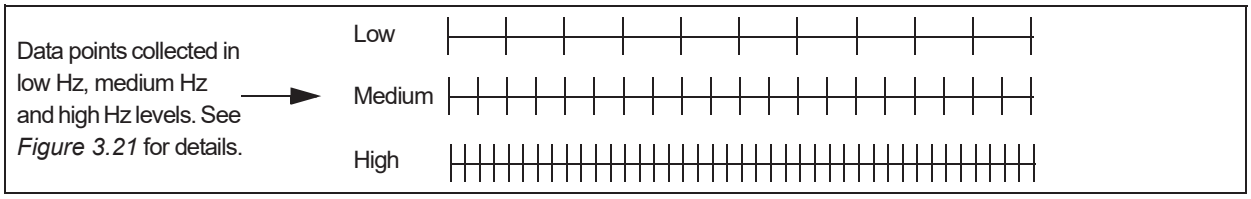
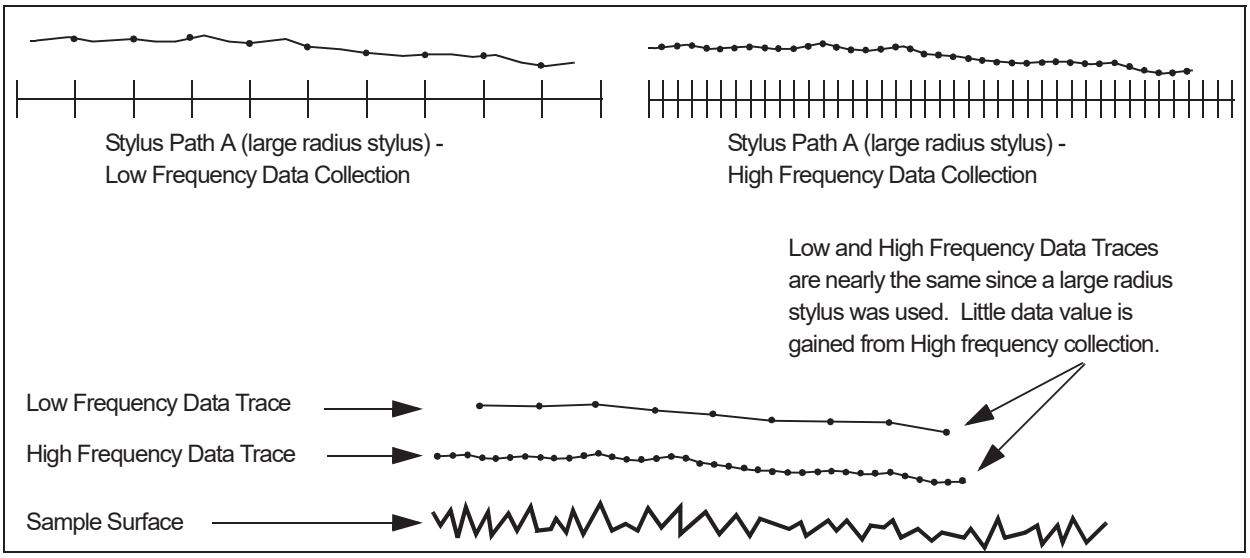
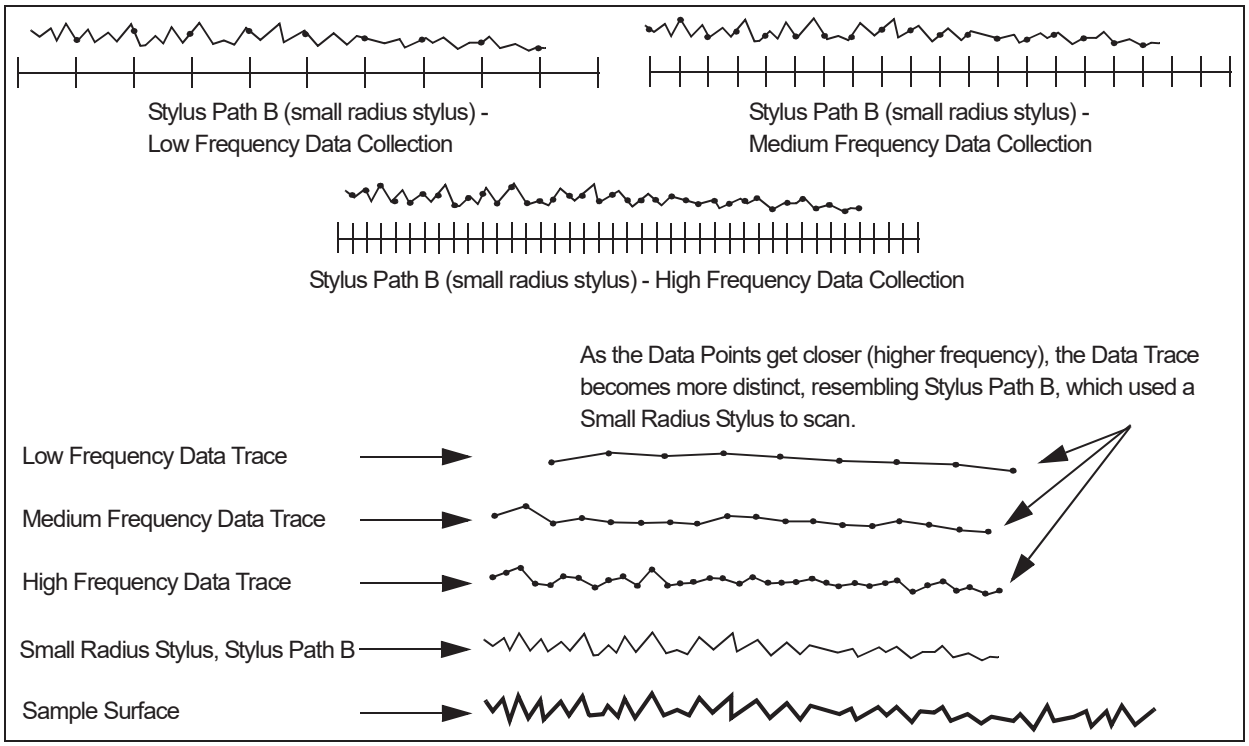


Figure 3.21 *Data Collection When Using a* ***Large Radius*** *Stylus*



If the Stylus chosen is small enough to detect the features of interest in the scan, then a sampling rate should be chosen that accurately records the level of detail required from the scan. For a small stylus radius, as the Sampling Rate increases, assuming the speed is left the same, the number of data points collected forms a trace that comes closer to the actual scan path features. (See *Figure 3.22*.)

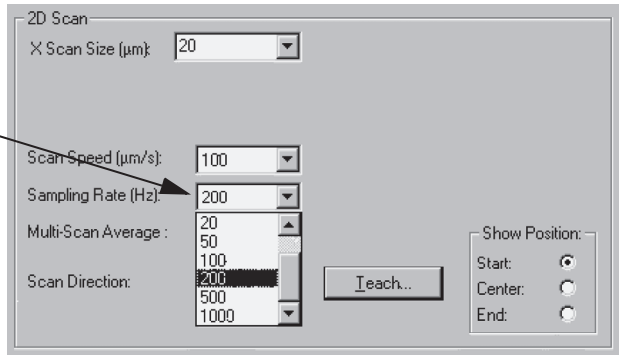
Figure 3.22 *Data Collection When Using a Small Radius Stylus*



Choose the desired Sampling Rate by clicking on the menu arrow next to Sampling Rate field. The recommended range is presented in the drop-down menu (5 Hz - 1000 Hz). Click on the desired rate from the menu.

Figure 3.23 *2D Scan Options With Sampling Rate Menu*

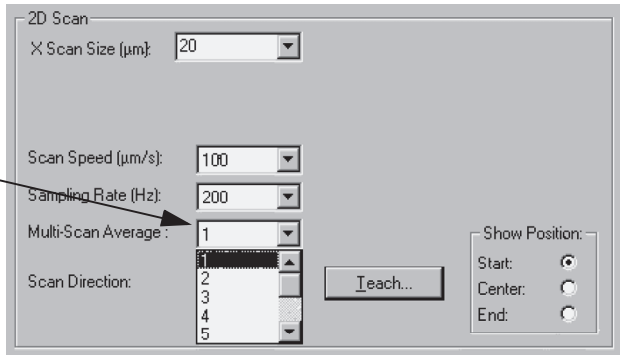
Step 3 Click on the menu arrow next to the **Sampling Rate** field. Click on the desired rate from the menu. The range is between 5 Hz and 1000 Hz.



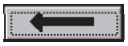
4. **Multi-Scan Average** - This is a 2D option that allows the user to repeat a single scan up to 10 times so that the scan data can be averaged by the number of scans performed. This feature provides an opportunity to level out the noise factors in a scan. The optimum Multi-Scan Average is between **3** and **5** times.

Figure 3.24 2D Scan Options With Multi-Scan Average Menu

Step 4 Multi-Scan Average sets the number of times a scan is run before the data is averaged to present the scan for analysis. Click on the menu arrow next to the variable box and click on the desired number of scans.



Click on the menu arrow next to the Multi-Scan Average to display its menu. Click on the number of scans to be performed for averaging the data.

5. **Scan Direction - Arrow** - This option dictates the direction of the scan, from left to right  or from right to left  .

   Changing The Scan Direction: Click on the arrow to cause it to point the opposite direction.

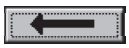
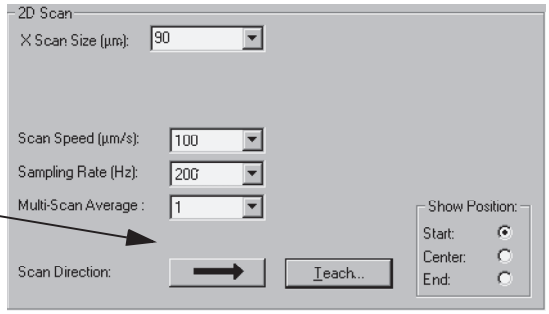
NOTE: DO NOT use  unless it is absolutely necessary. The recommended direction is left to right  because it gives better repeatability, protects the stylus, and provides better data.

Figure 3.25 2D Scan Options With Scan Direction Arrow

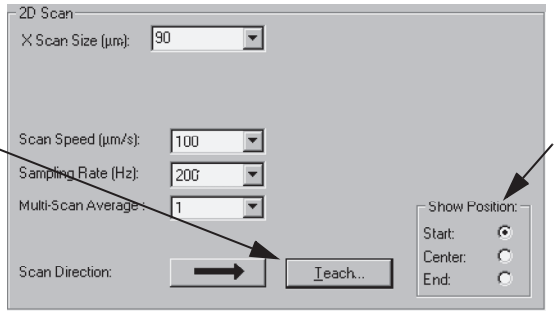
Step 5 The arrow dictates which direction the scan proceeds in. To change the scan direction, click on the arrow and it changes to indicate scan direction.



6. **Scan Direction - Teach** - When the **Teach** button is clicked on, it displays the **Teach Scan Length** screen. This screen allows the user to set the starting, center, or end positions of a scan. The scan length is already set in the **X Scan Size** parameter. Use the following procedure to set the **Teach...** position:

Figure 3.26 *2D Scan Options - Show Position:*

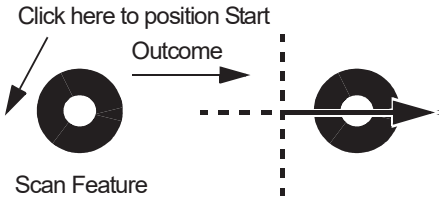
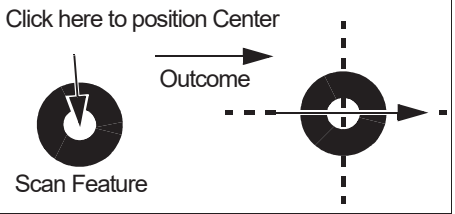
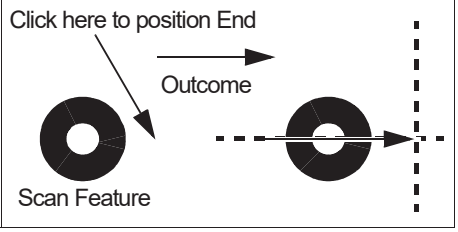
Step 5 *b.* Click on the **Teach…** button to display the Teach Scan Length screen where, in the XY View, the exact location of the chosen reference position can be established.



Step 5*a.* Before activating the **Teach…** button, click in the radio button representing the reference position to be used in the Teach Scan Length screen.

a. Before clicking the **Teach...** button, the desired **reference position** must be chosen. This is accomplished in the **Show Position** box, to the right of the **Teach…** button. Click in the radio button next to the desired reference position, **Start, Center**, or **End**, that is to be established with respect to the scan feature in the **Teach Scan Length** screen. (See *Figure 3.26*.)

Table 3.14 ***Show Position*** *Options*

Option	Description	Graphic Representation
Start	The **Start** setting is used in the Video portion of the XY view screen to position the start of the scan at the intersection of the Video screen crosshairs. Wherever the user clicks in the video image, that position becomes the starting scan position, and appears at the center of the Video screen, with the scan distance presented as an arrow.	
Center	The **Center** setting is used in the Video portion of the XY view screen to position the center of the scan at the intersection of the Video screen crosshairs. Wherever the user clicks in the video image, that position becomes the center of the scan, and appears at the center of the Video screen, with the scan distance presented as an arrow.	
End	The **End** setting is used in the Video portion of the XY view screen to position the end of the scan at the intersection of the Video screen crosshairs. Wherever the user clicks in the video image, that position becomes the end of the scan, and appears at the center of the Video screen, with the scan distance presented as an arrow.	

b. Locate the desired feature in the XY View portion of the screen. Click on the reference position (start, center, or end). The screen then positions the scan length arrow over the scan feature according to the chosen position. The reference position is at the center of the video screen crosshairs. (See *Table 3.14*.)

NOTE: When in the **Teach Scan Length** (XY view) screen, it is possible to change the scan length by clicking on a position in the video screen and dragging the new length. If the scan is immediately started from the Teach Scan Length screen, it scans the newly defined (dragged) distance even though the original recipe scan length is different. However, if the new distance is not saved it does not appear on the original recipe. If it is saved by clicking OK or actually saving the changes from the menu, the recipe then reflects the newly dragged scan distance.

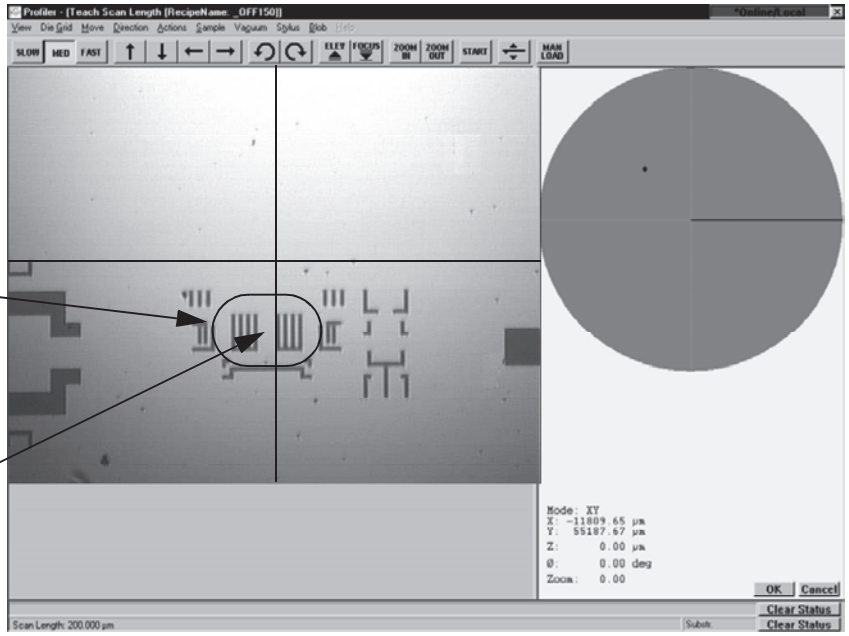
Figure 3.27 *Teach Scan Length, from the 2D Scan Teach Button*

With the feature in the field of view, click in the appropriate reference point (start, center, or end) for the scan. The system positions that point center screen and places the scan arrow over the scan in the appropriate place.

EXAMPLE: If the circled feature is to be scanned…

and the reference is set on **center**…

Click on the center of the scan travel distance in the image and that point is positioned center stage with the scan trace through it.



3D Scan Category Parameters - Scan Parameters Definition

The parameters discussed in this section are those that are **additions to** or **differ from** the 2D parameters already presented. For information on parameters that are identical for 2D and 3D scans, see the descriptions in the 2D recipe section. (See *Table 3.15* for identification of which parameter settings are 2D or 3D.)

Table 3.15 *3D Scan Parameters Summary*

Parameter Setting	2D, 3D or Both	Description and Location
X Scan Size	Both	X direction scan length; Step *1. on page 3-17*.
Y Scan Size	3D	The length in the Y-direction through which the X-direction scans are made at each **Y Spacing** interval.
Scan Speed	Both	The speed at which the scan is performed.
Sampling Rate	Both	The rate at which data points on the scan are recorded for analysis.
Traces	3D	This is the number of scans that are made to encompass the Y-distance requirement.
Multi-Scan Average	2D	The number of single identical scans which are performed and used to create a scan data set that represents the average of the scans.
Spacing	3D	This is the distance between X scans performed across the Y direction of the 3D scan area.
Scan Direction	Both	The direction in which the scan is performed.
Teach…	Both	Displays the **Teach Scan Length** screen that is used to determine the start, center or end of the scan. Can also be used to drag a new scan length.
Show Position	Both	Displays the current position and provides an opportunity to set a new position at which the scan, of scan length set in **X Scan Size**, is started, is centered, or ends.

Y Scan Size (μm)

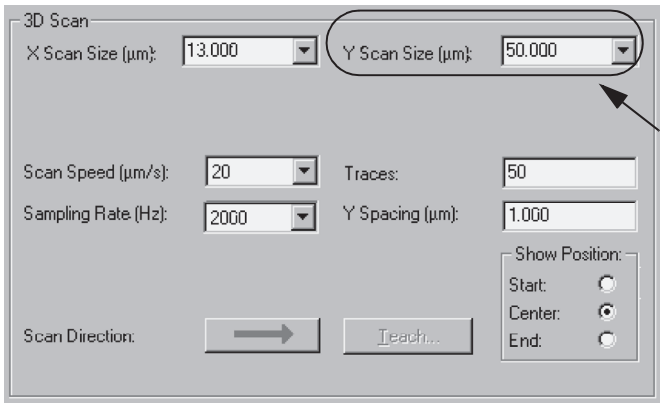
This parameter defines the size, in the Y-direction, of the 3D area to be scanned. It is the area across which the number of scans defined in the parameter **Traces** are divided up. (See *Figure 3.29 on page 3-26*.)

NOTE: If the variable in the **Spacing** parameter is changed, the **Y Scan Size** changes to accommodate the number of **Traces** at the new **Spacing** distance.

Setting or Changing Y Scan Size - Use one of the following procedures:

- Click the menu arrow to the right of the **Y Scan Size** field and click on the desired size.
- Highlight the current number and type in the new number. (See also **Automatic Parameter Adjustment**: in Step *on page 3-27*.)

Figure 3.28 *3D Scan Parameters*

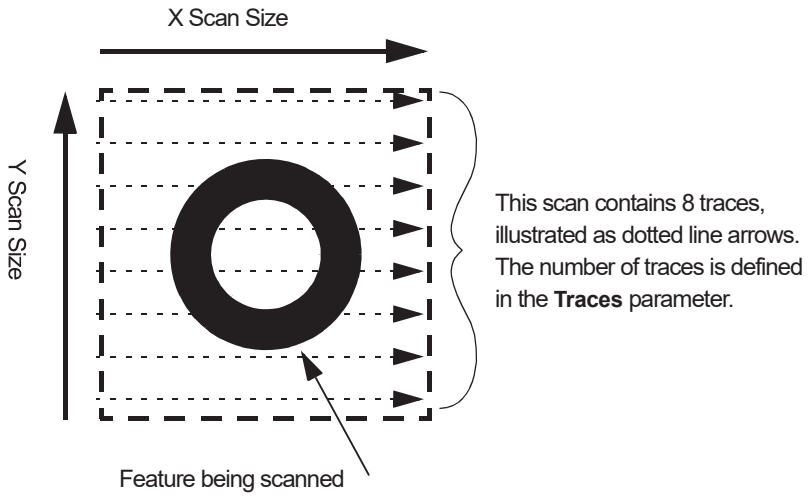


Set the **Y Scan Size** by clicking on the menu arrow and choosing the desired size, or by highlighting the current number and typing in the new number.

Traces

This assigns the number of scans that are made in the X-direction across the **Y Scan Size** direction. In *Figure 3.29*, the number in the **Traces** variable box would be **8**.

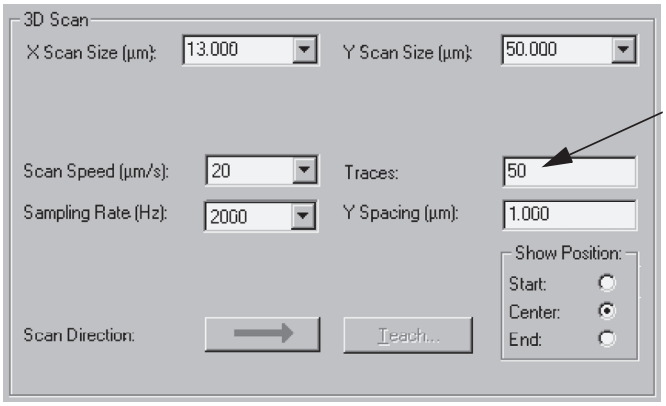
Figure 3.29 *Traces - Scan Perimeter with Traces*



If the **Y Scan Size** is set [Y Scan Size = (Traces -1) x Y Spacing], when the **Traces:** parameter is entered, the **Y Spacing** parameter automatically adjusts to reflect the appropriate spacing between scans.

Setting the Number of Traces: To change the number of **Traces** in a 3D scan, highlight the current **Traces** value and type in the new number of traces. (See also **Automatic Parameter Adjustment**: in *Y Spacing (mm)* on page 3-27.)

Figure 3.30 *3D Scan -* **Traces** *Parameter*



Y Spacing (µm)

This variable sets the distance in the Y-direction between X-direction scan traces in a 3D scan.

The spacing is very important to final 3D data collection set because, together with the stylus radius, it determines the essential resolution of the feature that is scanned. (See Step 3 on page -18.) Consider to following examples:

- If the distance between scans is too great with respect to the stylus radius, important variations in the scanned feature might be missed.
- Conversely, if using a larger stylus, and the distance between scans is very small, many of the data points are essentially redundant and, therefore, meaningless.

Automatic Parameter Adjustment: - In general, a connection exists in the software such that, when certain parameters are changed, other parameters are readjusted to accommodate the changes. The adjustments occur between the **Y Scan Size**, **Traces**, and **Y Spacing** parameters. Occasionally, after setting a parameter, the user might click on one of the other parameters and notice a minor adjustment to the parameter that had just been set. This happens to balance the numbers between **Y Scan Size**, **Traces**, and **Y Spacing**. (See *Table 3.16*.)

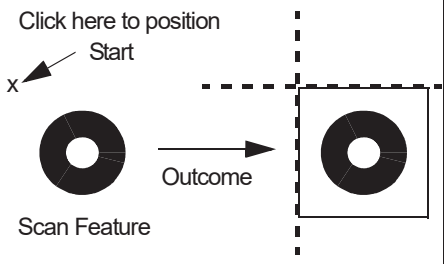
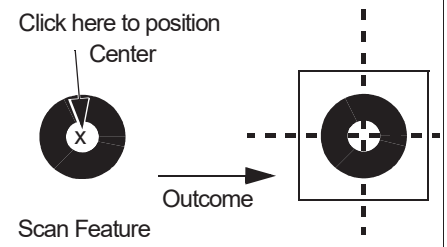
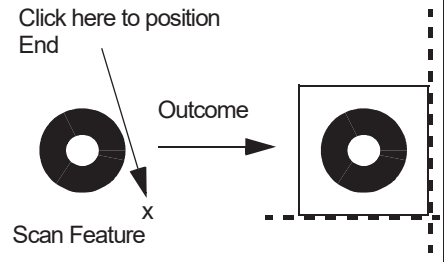
Table 3.16 *Automatic Parameter Adjustments*

Change This Parameter	Adjusts These Parameter	Conditions Effecting Adjustment
Y Scan Size	Y Scan Size	Occasionally makes minor adjustments to the newly set number to accommodate the Y Spacing or Traces.
	Y Spacing	
	Traces	Occasionally makes minor adjustments (no more the ±1) to the newly set number, to accommodate the Y Scan Size and Y Spacing. Usually only for scans less than 100 μm.
Traces	Y Scan Size	This change is normally small, changing to accommodate the spacing required to perform the number of traces.
	Y Spacing	
	Traces	Occasionally makes minor adjustments (no more the ±1) to the newly set number, to accommodate the Y Scan Size and Y Spacing. Usually only for scans less than 100 μm.
Y Spacing	Traces	
	Y Scan Size	This change is normally small, changing to accommodate the spacing required to perform the number of traces.
	Y Spacing	Occasionally makes minor adjustment to the newly set number to accommodate the Y Scan Size or Traces.
Scan Speed	No Changes	
Sampling Rate	No Changes	

1. **Show Position** - For 3D scans, the three options in this box are used for positioning the scan area parameters box, not to indicate the actual Start and End of the scan. One of these options must be chosen in conjunction with the **Teach...** position function button next to the **Show Position** box. (See *Table 3.17*.)

   Selecting An Option: Click in the radio button of the desired position.

***Table 3.17 Show Position** Options*

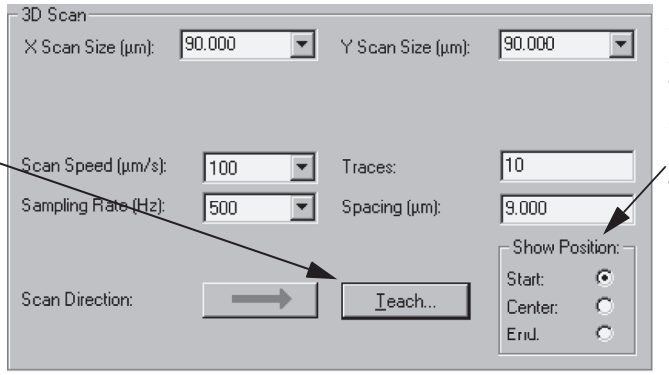
Show Position Option	Description	Graphic Representation
Start	The **Start** setting is used in the Video portion of the XY view screen to position the upper left corner of the scan area box in the Video screen crosshairs. Wherever the user clicks in the video image, that position becomes the upper left corner of the scan area box, and appears at the center of the Video screen. This is not the actual place where the scan starts. **Start** only defines the upper left corner of the scan area box. Literal START is near the lower left corner.	
Center	The **Center** setting is used in the Video portion of the XY view screen to position the center of the scan area box in the center of the Video screen crosshairs. Wherever the user clicks in the video image, that position becomes the center of the scan area box, and appears at the center of the Video screen.	
End	The **End** setting is used in the Video portion of the XY view screen to position the lower right corner of the scan area box in the center of the Video screen crosshairs. Wherever the user clicks in the video image, that position becomes the end of the scan area box, and appears at the center of the Video screen. This is not the actual place where the scan ends. **End** only defines the lower right corner of the scan area box. Literal END is near the upper right corner.	

2. **Teach...** - This function takes the feature and positions it in the scan field according to the reference position option chosen in the **Show Position** box. (See also Step *1. on page 3-29*.)

a. Before clicking the **Teach...** button, the desired **reference position** must be chosen. This is accomplished in the **Show Position** box, to the right of the **Teach...** button. Click in the radio button next to the desired reference position, **Start, Center**, or **End**, that is to be established with respect to the scan feature in the **Teach Scan Length** screen. (See *Figure 3.31*.)

Figure 3.31 *2D Scan Options - Show Position:*

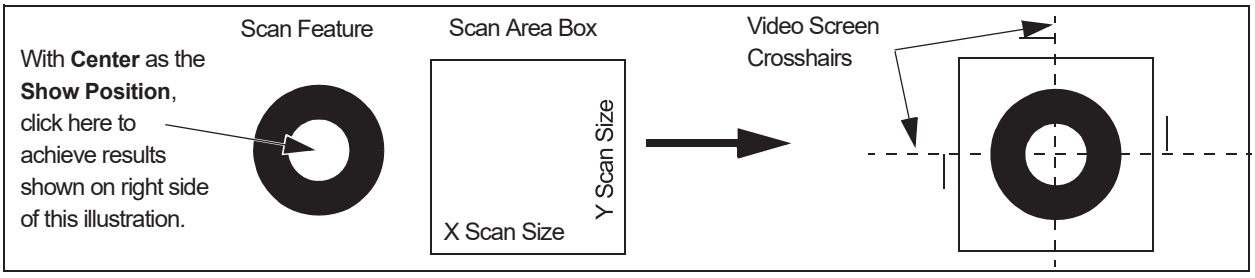
Step 2 Click on the **Teach…** button to display the Teach Scan Length screen where, in the XY View, the exact location of the chosen reference position can be established.



Step 1 Before activating the Teach… button, click in the radio button representing the reference position to be used in the Teach Scan Length screen.

b. Locate the desired sample feature in the Video portion of the screen. Click on the position that corresponds to the reference position (Start, Center, or End), that is on or near the scan feature. The screen positions the scan area box over the scan feature according to the chosen position. The chosen position (Start, Center, or End) is at center screen, with the scan area box positioned accordingly. (See *Figure 3.32*, *Figure 3.33* & *Figure 3.34*.)

Figure 3.32 *Teaching a Scan Position Using* ***Center Show Position***



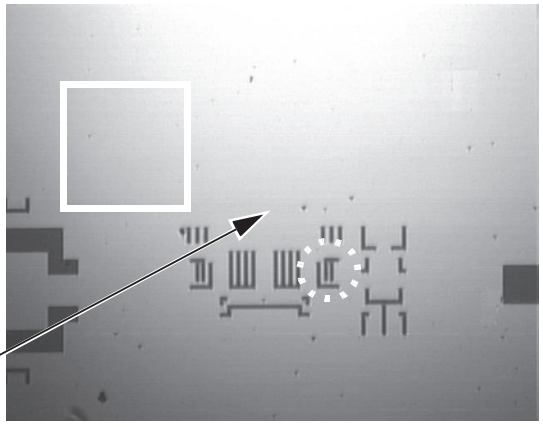
NOTE: When in the **Teach Scan Length** screen, it is possible to change the scan area by clicking on a position in the video screen and dragging the box to form a new area. If the scan is immediately started from the **Teach Scan Length** screen, it scans the newly defined (dragged) area even though the original recipe scan area is different. However, if the new area parameters are not saved, they do not appear in the original recipe. If they are saved by clicking **OK** or actually saving the changes using the **File** menu, the recipe will reflect the newly dragged scan distance.

Figure 3.33 *Teaching a Scan Position Using* ***Start Show Position***

Assume that the features represented in the illustration were on the video screen.

- The feature with the dashed circle around it is the object of the scan,
- The white box represents the scan area defined by **X Scan Size** and **Y Scan Size**,
- **Start** is the **Show Position**.

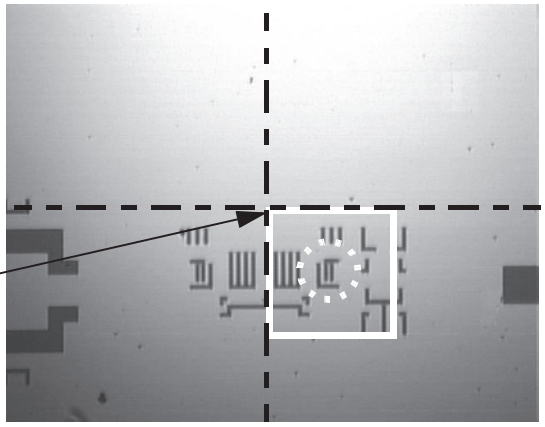
Clicking here places the scan area box around the feature and sets this spot at the center of the view screen. (See results in *Figure 3.34*.)



The preceding illustration demonstrates the use of the **Teach...** function from the 3D Scan parameters in the Recipe Editor. The illustration uses the **Start** option from the **Show Position** box. The results are demonstrated in *Figure 3.34*.

Figure 3.34 *Teaching a Scan Position Using* ***Start Show Position***

The scan area box aligns with the **Start** position at the point on the screen where the user clicks.



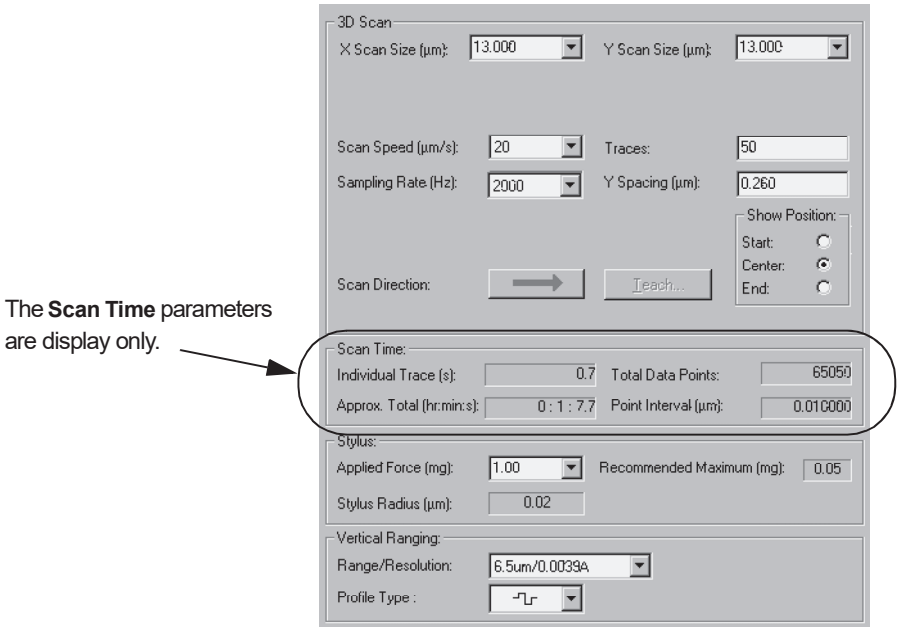
NOTE: The simplest way to set up a 3D scan is to choose **Center** as the **Show Position** and click directly in the center of the scan feature. This places the center of the feature in the center of the scan area box, and places the scan area box at the center of the screen crosshairs.

Scan Time Parameters (2D and 3D) - Scan Parameters Definition

The **Scan Time** parameters box displays time and data point values, broken down into general components. (See *Figure 3.35*.) No values can be set or defined in this portion of the screen. These values are read only because they are determined by parameters set in other fields.

NOTE: These values are system generated from parameters set in other fields. This value **might be inaccurate up to 20%** of the actual value. Use these values only for casual reference.

Figure 3.35 *Scan Time - Scan Parameters Definition*



Individual Traces (s)

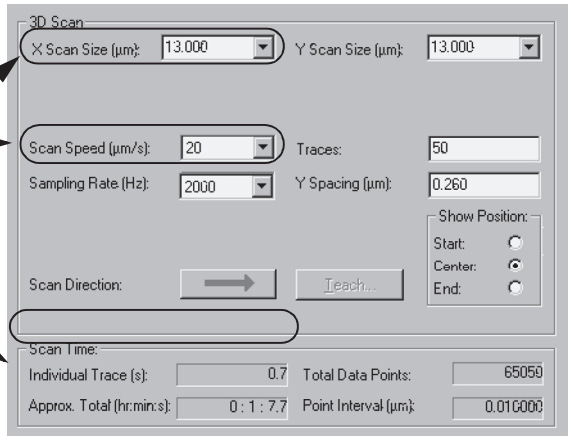
This defines the number of seconds required to complete one scan. This time parameter divides **X Scan Size (µm)** by **Scan speed (µm/s)** and adds the result to the approximate **move time**. (See *Figure 3.36*.)

CAUTION: The following equation is not the actual equation used to produce the variables. The equation only takes into consideration the simplest and most general components used to produce the value displayed in the field. *Use generate values only for casual reference.*

For 2D and 3D [**X Scan Size** / **Scan speed**] + **move time** = **Individual Traces (s)**

Figure 3.36 *Individual Traces Calculation*

Individual Traces (s) parameter is calculated using the **X Scan Size (µm)** and the **Scan Speed (µm/s)** settings. The calculated time is added to the move time to give the total **Individual Traces (s)** time.

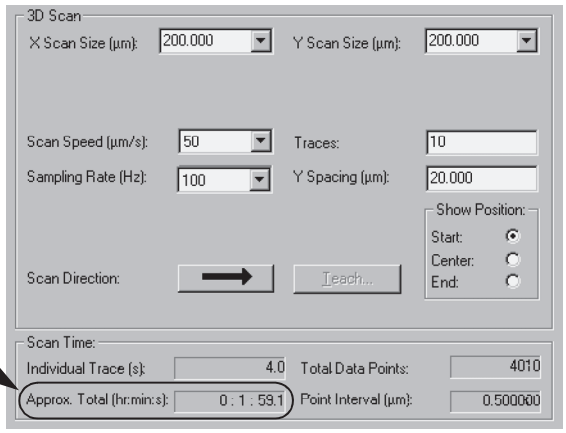


Total (hr:min:s) - This is the total time that it takes to complete the set of scans defined in the scan recipe section, **2D** or **3D Scan**.

CAUTION: Generating the value for the **Approx. Total (hr:min:s)** is very complicated. This variable can be inaccurate up to 20% in either direction. *Use the generated time only for casual reference.*

Figure 3.37 **Total (hr:min:s):** *Calculation - 3D Screen*

Approx. Total (hr:min:s:).



Number of Data Points: - This is the total number of scan data points collected during the scan.

CAUTION: The following equation is not the actual equation used to produce the variables, it only approximates it. This equation only takes into consideration the simplest and most general components used to produce the value displayed in the field. *Use generate values only for casual reference.*

For 3D **[(X Scan Size / Scan Speed) x Sampling Rate x Traces] + the number of traces = Number of Data Points**

For 2D **[X Scan Size / Scan Speed] x Sampling Rate x Multi-Scan Average = Number of Data Points**

The approximate value is seen in the following example

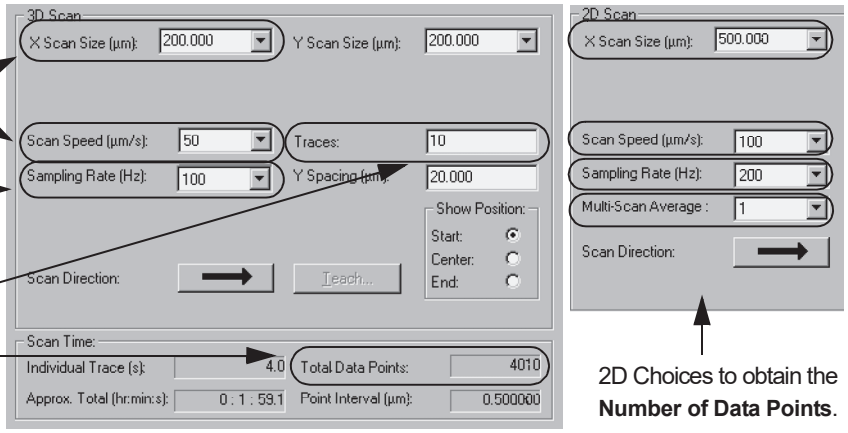
Figure 3.38 **Number of Data Points:** *Calculation - 2D & 3D Screens*

The **Number of Data Points** is calculated by taking **X Scan Size** and dividing it by **Scan Speed**, then…

multiply the result by the **Sampling Rate**, then…

multiply the result by the number of **Traces**.

This approximately equals the **Number of Data Points**.



2D Choices to obtain the **Number of Data Points**.

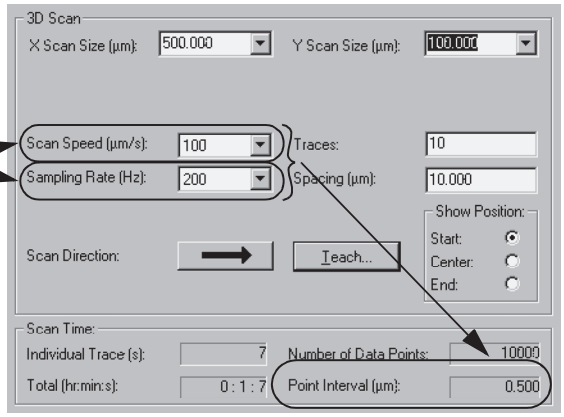
Point Interval

Point Interval is the distance between data points in the X-direction of each trace.

For 2D and 3D **Scan Speed (µm)** / **Sampling Rate (Hz)** = **Point Interval:**

Figure 3.39 **Point Interval:** *Calculation - 3D Screen*

Point Interval is the distance between data points in each X-direction scan trace. It is defined as the **Scan Speed** divided by the **Sampling Rate**.

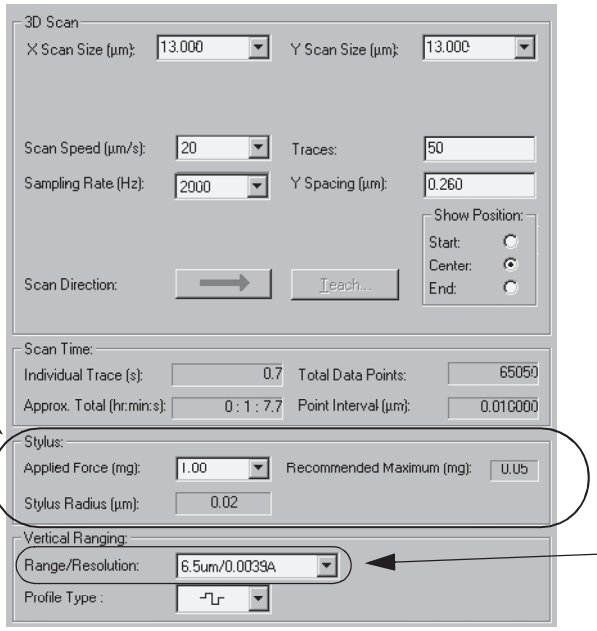


Stylus Parameters (2D and 3D) - Scan Parameters Definition

The **Stylus** parameters box contains those variables that deal with the stylus operation. Only the Applied force variable is accessible for change in this screen.

Figure 3.40 *Stylus Parameters (2D and 3D)*

Applied Force is the only parameter in **Stylus** that is adjustable. Click on the menu arrow to display the menu and choose the force.



6.5 mm is the hi gain range.

Applied Force (mg)

This is the force exerted by the stylus on the sample surface. With each different stylus radius there are recommended limits that should be taken into consideration when setting the **Applied Force**. The **Applied Force** should not exceed the recommended maximum force. (See *Figure 3.41*.)

Figure 3.41 *Stylus Parameters - Scan Parameters Definition*

Applied Force is the only adjustable parameter in the Stylus box.

Applied Force should not exceed this limit.

Table 3.18 *Stylus Force Ranges for the Different Head Configurations*

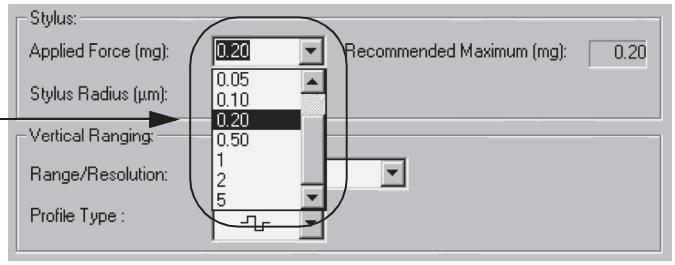
MH2lf	MH2sr	MH2xr
0.05-50 mg in *hi gain* range (0.1 mg for medium and low ranges)	1-50 mg	0.5-50 mg

Changing the **Applied Force** setting:

1. Click on the menu arrow next to the variable box to display its menu.
2. Click on the desired force setting. (*Figure 3.42*.)

Figure 3.42 *Stylus Parameters - With Applied Force Menu*

To change the **Applied Force** value, click on the menu arrow to the right of the variable box to display the menu. Click on the desired force setting.



NOTE: The force setting must be within the range of the head being used or a message is generated that requires the user to choose an appropriate setting.

Stylus Radius (μm)

Stylus Radius is the manufacturers stated radius of the stylus. The stylus radius cannot be changed in this screen.

CAUTION: Recommendations and limits are only correct if the "Stylus Change Procedure" was followed when the stylus was installed.

Use the Stylus Change Procedure to change the stylus radius setting. (See *Stylus Change Procedure* on page 4-1.)

Recommended Maximum (mg)

Each stylus type is associated with a maximum applied force setting. The maximum setting is deemed to be safe for the stylus and the sample while performing normal scans. This force should not be exceeded.

CAUTION: See *Table 3.13 on page 3-18* for special recommended force limitation when using any submicron tip on a soft sample. This number is set during the Stylus Change Procedure. If that procedure is not used when changing a stylus the recommended force could be incorrect. If a user sets the wrong Applied Force and exceeds the actual recommended force, stylus damage or potential damage of soft sample surfaces could occur.

Vertical Ranging Parameters (2D and 3D) - Scan Parameters Definition

Vertical Ranging contains two parameters: **Range/Resolution** and **Profile Type**. These two parameters are used together to set up the system for:

- Range: The maximum feature measurement limit (theoretical), up or down, that is considered when scanning for a feature,
- Resolution: The theoretical vertical resolution of the scan of a feature.

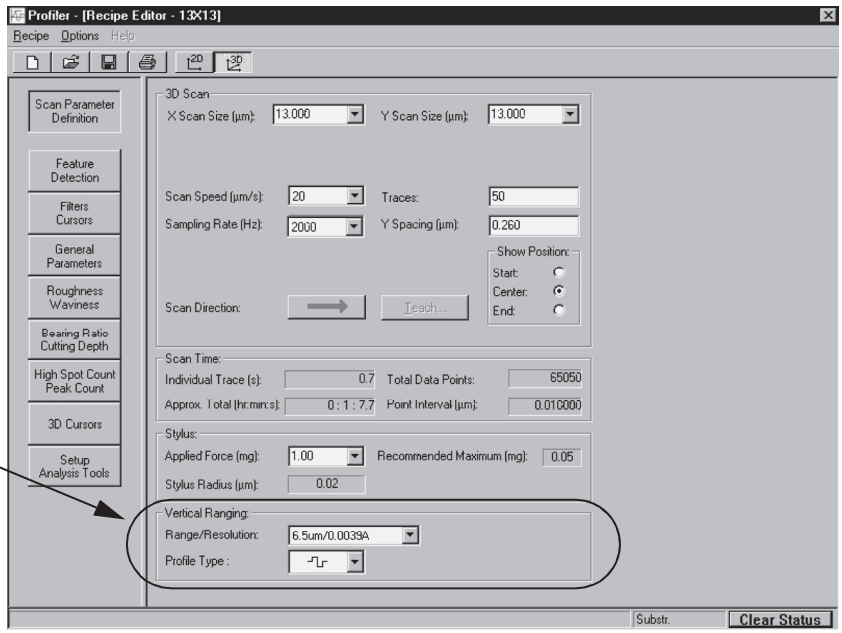
Three set of ranges are available depending on the type of head the instrument uses. The primary differences between the ranges are in their resolution capabilities, and the ability in the 131 µm, 327 µm, and 1000 µm range to set the direction in which the range is applied. The ranges are described below.

Figure 3.43 *Recipe Editor - 3D Scan Parameter Definition*

The **VERTICAL RANGING** parameters box defines:

1. Which vertical features are scanned; those in the up, down, or both up and down direction, from the scans starting level.

2. The maximum theoretical height, depth or both height and depth of features that are considered, along with the minimum feature size that, theoretically, can be clearly resolved.



Range/Resolution

This parameter sets the maximum size limit of the features that can be scanned in each given range, and the minimum feature size that can be resolved (positively detected). Three ranges are available. (See *Table 3.19*.)

Table 3.19 *Range and Resolution Scan Parameters for the **MH2lf** Head*

Vertical Range (µm)	Resolution (Å)
± 3.2 (6.5 total)	0.004
± 13 (26 total)	0.016
± 65 (131 total)	0.08

Table 3.20 *Range and Resolution Scan Parameters for the **MH2sr** Head*

Vertical Range (µm)	Resolution (Å)
± 6.5 (13 total)	0.008
± 32 (64 total)	0.04
± 173 (327 total)	0.2

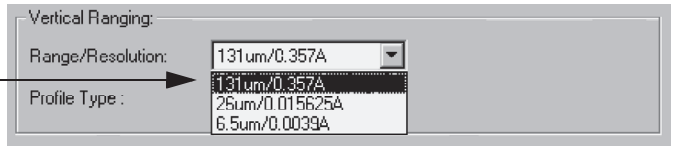
Table 3.21 *Range and Resolution Scan Parameters for the* ***MH2xr*** *Head*

Vertical Range (μm)	Resolution (Å)
± 6.5 (13 total)	0.008
± 65 (131 total)	0.08
± 500 (1000 total)	0.6

NOTE: The Resolution numbers in *Table 3.19*, *Table 3.20*, and *Table 3.21* are theoretical. Noise levels could greatly effect the resolution.

Figure 3.44 ***Vertical Ranging*** *- Range/Resolution Menu*

To choose the 131 μm range, click on the menu arrow next to the variable box to display the menu. Click on 131 μm.



131 µm, 327 µm, and 1000 µm ranges - The largest features are scanned using these ranges. In this range, using the **Profile Type** menu (see *Figure 3.45* and *Table 3.22*), the user can specify which features are considered for analysis:

- Features that step **UP** a maximum of 131 µm from the scan's starting point;
- Features that step **DOWN** a maximum of 131 µm from the scan's starting point;
- Or features that step ±65 µm, **BOTH UP AND DOWN,** from the scan's starting point

Choosing the 131 µm, 327 µm, or 1000 µm range:

Click on the menu arrow to display the menu. Click on the desired option. (See *Figure 3.44*.)

Range Limitations for 131 µm (MH2lf head):

- The limit for a scan with the Profile Type  is ±65 µm.
- The limit for a scan with the Profile Type  is approximately 65 µm + (1/2 x 65 µm) ≈ 100 µm.
- The limit for a scan with the Profile Type  is approximately -65 µm + (1/2 x -65 µm) ≈ -100 µm

Range Limitations for 327 µm (MH2sr head):

- The limit for a scan with the Profile Type  is ±163 µm.
- The limit for a scan with the Profile Type  is approximately 160 µm + (1/2 x 160 µm) ≈ 240 µm.
- The limit for a scan with the Profile Type  is approximately -160 µm + (1/2 x -160 µm) ≈ -240 µm

Range Limitations for 1000 µm (MH2xr head):

- The limit for a scan with the Profile Type  is ±500 µm.
- The limit for a scan with the Profile Type  is approximately 500 µm + (1/2 x 500 µm) ≈ 750 µm.
- The limit for a scan with the Profile Type  is approximately -500 µm + (1/2 x -500 µm) ≈ -750 µm.

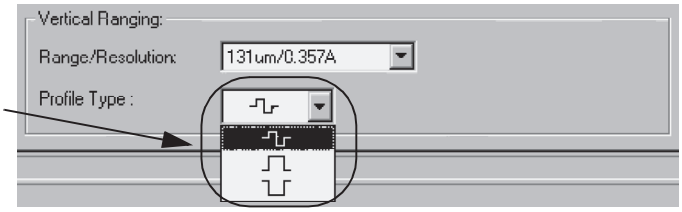
NOTE: The best results are obtained from the profile.

Saturated Data Points

If, in the course of a scan, the upper limit of any one of the ranges is reached and 50 data points are collected beyond the limit, the system aborts the scan and a message is issued reporting that there are too many saturation data points. The scan appears as complete, however, the end of the trace is only a continuation of the last data point, not actual scan data.

Figure 3.45 *Vertical Ranging - Profile Types*

For the 131, 327, and 1000 µm ranges, the three Profile Types allow the user to choose features that go up or down from the sample surface the full range, or split the difference between up and down features.



26 µm and 64 µm Ranges - These are the most common scan range for small scans. They offer the opportunity to scan features which are ±13 µm or ±32 µm from the scan starting point. These ranges do not offer the Up only or Down only option. (See *Table 3.22*.) If larger features are to be scanned, use the 131 µm, 327 µm, or 1000 µm range.

Choosing the 26 µm or 64 µm range:

Click on the menu arrow to display the menu. Click on the 26 or 64 µm range.

Range Limitations for 26 µm:

- The limits for a scan with the Profile Type is ±13 µm

Range Limitations for 64 µm:

- The limits for a scan with the Profile Type is ±32 µm.

Saturated Data Points

If, in the course of a scan, the upper limit is reached and 50 data points are collected beyond the limit, the system aborts the scan and a message is issued reporting that there are too many saturation data points. The scan appears as complete, however, the end of the trace is only a continuation of the last data point, not actual scan data.

6.5 µm and 13 µm Ranges - These are the most sensitive scan range. It is for scans of features 3.2 µm or smaller above or below the sample surface. This range does not offer the Up only or Down only option. (See *Table 3.22*.) If larger features are to be scanned, use either the medium range or the largest range.

Choosing 6.5 µm or 13 µm range:

Click on the menu arrow to display the menu. Click on **6.5 µm/0.015625Å**.

Range Limitations for 6.5 µm:

- The limits for a scan with the Profile Type is ±3.2 µm

Range Limitations for 13 µm:

- The limits for a scan with the Profile Type is ±6.5 µm.

If, in the course of a scan, the upper limit is reached and 50 data points are collected beyond the limit, the system aborts the scan and a message is issued reporting that there are too many saturation data points. The scan appears as complete, however, the end of the trace is only a continuation of the last data point, not actual scan data.

Profile Type*: Available choices for each range and the resultant scan traces*

Table 3.22 *Profile Types*

Profile Type	Range	Scan	Description
	131 µm 327 µm 1000 µm	131 µm scans features that are **65 µm up** or **down** from the scan's starting point. 327 µm scans features that are **160 µm up** or **down** from the scan's starting point. 1000 µm scans features that are **500 µm up** or **down** from the scan's starting point.	During a scan using this profile type, if the scan goes out of range and stays out of range for 50 data points, the scan is aborted. When operating in this range, the sensor arm containing the stylus can be very near its vertical limit capacity. When it goes out of range for 50 data points on a **step up**, the scan is aborted. If the scan continued to go further out of range, at some point the sensor could be damaged. When it goes out of range for 50 data points on a **step down**, the scan is aborted. If the scan continued to go further out of range, the stylus would float out of contact with the sample.
	64 µm	This scans features that are **32 µm up** or **down** from the scan's starting point.	During a scan using this profile type, if the scan goes out of the **±32 µm** range and stay out of range for 50 data points, the scan is aborted. These limits are in the software. The system sends a saturation message when the scan is aborted.
	26 µm	This scans features that are **13 µm up** or **down** from the scan's starting point.	During a scan using this profile type, if the scan goes out of the **±13 µm** range and stay out of range for 50 data points, the scan is aborted. These limits are in the software. The system sends a saturation message when the scan is aborted.
	13 µm	This scans features that are **6.5 µm up** or **down** from the scan's starting point.	During a scan using this profile type, if the scan goes out of the **±6.5 µm** range and stay out of range for 50 data points, the scan is aborted. These limits are in the software. The system sends a saturation message when the scan is aborted.
	6.5 µm	This scans features that are **3.2 µm up** or **down** from the scan's starting point.	During a scan using this profile type, if the scan goes out of the **±3.2 µm** range and stay out of range for 50 data points, the scan is aborted. These limits are in the software. The system sends a saturation message when the scan is aborted.

Table 3.22 *Profile Types (Continued)*

Profile Type	Range	Scan	Description
	131 µm 327 µm 1000 µm	131 µm scans features ≈ **100 µm up** from the scan's starting point. 327 µm scans features ≈ **240 µm up** from the scan's starting point. 1000 µm scans features ≈ **750 µm up** from the scan's starting point.	During a scan using this profile type, if the scan goes out of range and stays out of range for 50 data points, the scan is aborted. When operating in this range, the sensor arm containing the stylus is actually very near its physical capacity. When it goes out of range for 50 data points on a **step up**, the scan is aborted. If the scan continued to go further out of range, at some point the sensor could be damaged.
	131 µm 327 µm 1000 µm	131 µm scans features ≈ **100 µm down** from the scan's starting point. 327 µm scans features ≈ **240 µm down** from the scan's starting point. 1000 µm scans features ≈ **750 µm down** from the scan's starting point.	During a scan using this profile type, if the scan goes out of the range and stays out of range for 50 data points, the scan is aborted. When operating in this range, the sensor arm is actually very near its physical capacity. When it goes out of range for 50 data points on a **step down**, the scan is aborted. If the scan continued to go further out of range, the stylus would simply float out of contact with the sample.

Feature Detection (Only for 2D Scans)

Feature Detection is used to enable automatic detection of some common classes of profile features (see *Figure 3.47* and *Figure 3.48*). Feature detection facilitates measurement throughput and consistency. It also makes it possible to automatically and reliably set the position of the measurement and leveling cursors relative to the rising and falling edge of a step-like feature or the apex of an arc-like feature.

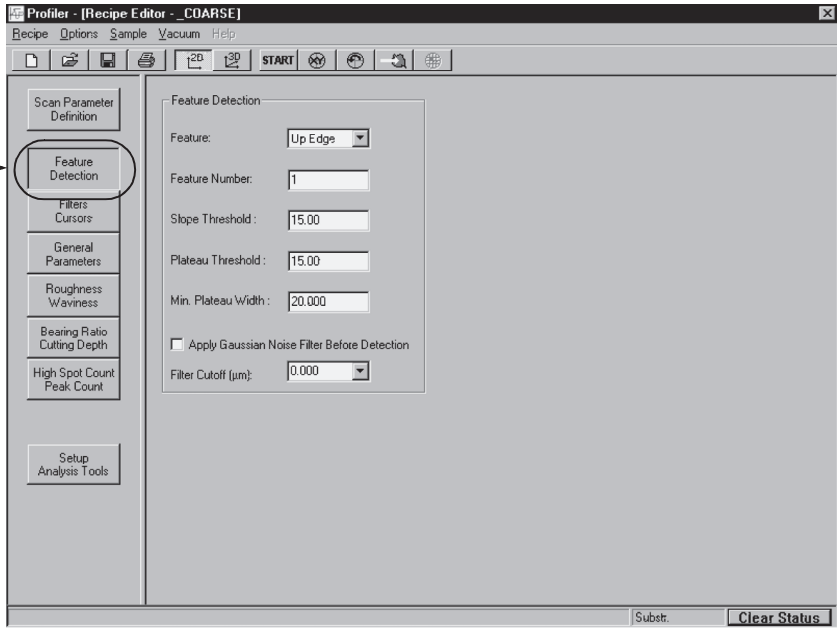
In conjunction with feature detection, both the location of the edge (or the apex of an arc) and the step width can be calculated and displayed in the Analysis window.

Accessing the Feature Detection parameters:

In the **Recipe Editor,** click on the **Feature Detection** button. (See *Figure 3.46*.) For information on how to display the **Recipe Editor**, see *Accessing the Scan Recipe Editor* on page 3-13.

Figure 3.46 *Feature Detection - Recipe Editor*

To display the **Feature Detection** parameters in the Recipe Editor Information Display window, click on the **Feature Detection** button.



Feature

This parameter allows the user to choose between six different features that can be detected and identified during a scan.

Figure 3.47 *Feature Detection Point Locations on a Step*

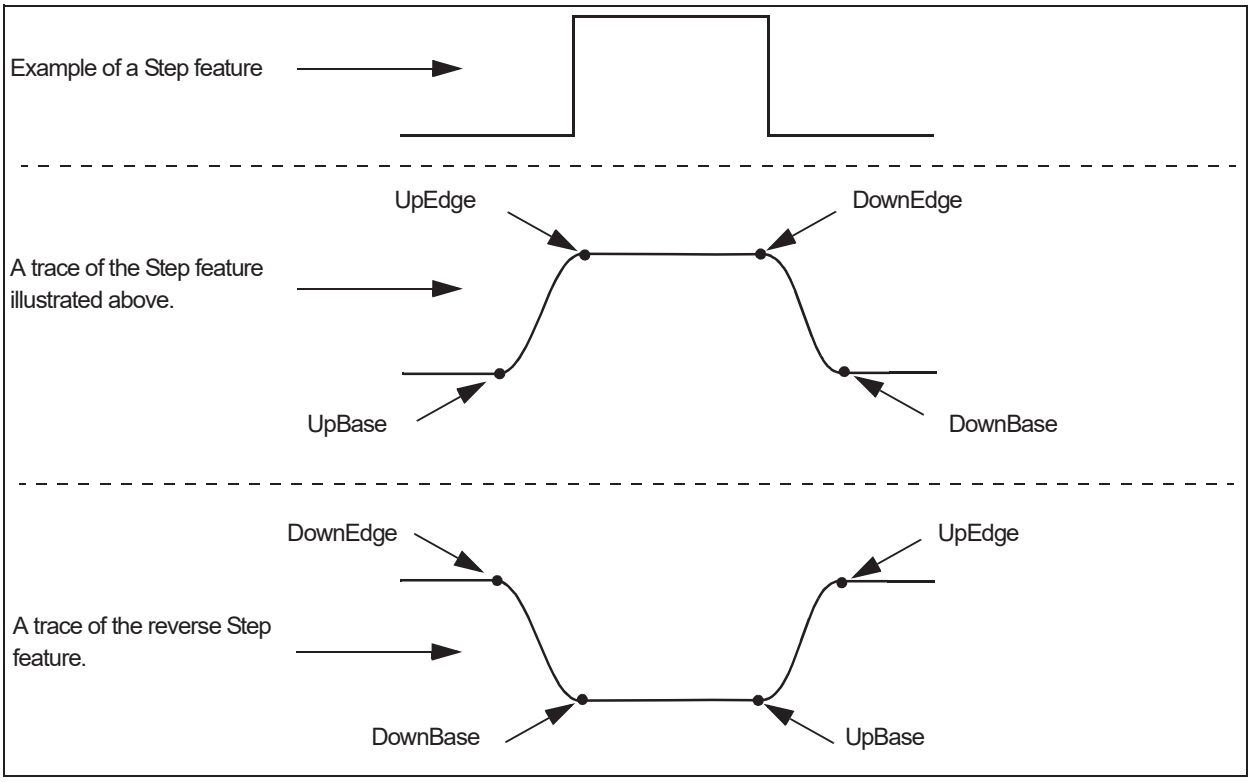


Figure 3.48 *Feature Detection Point Locations for Convex and Concave*

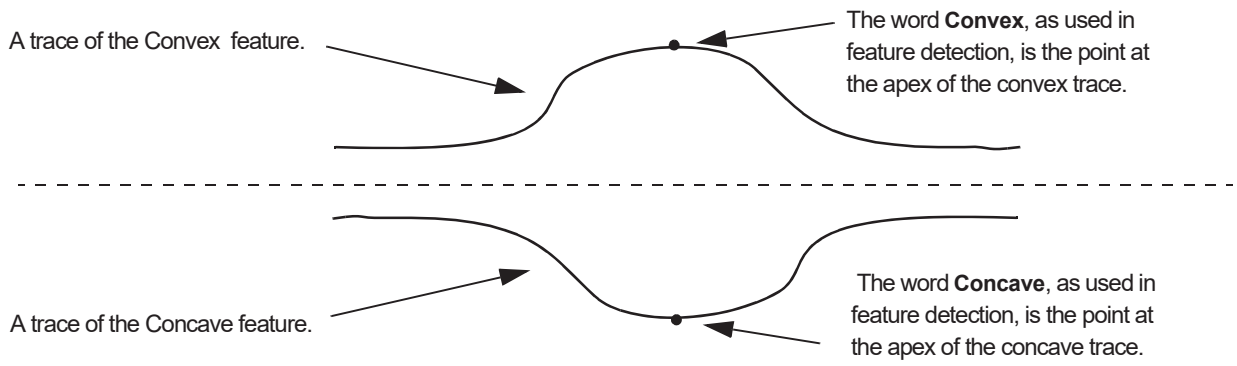


Table 3.23 *Feature Detection Descriptions (See Figure 3.47 and Figure 3.48.)*

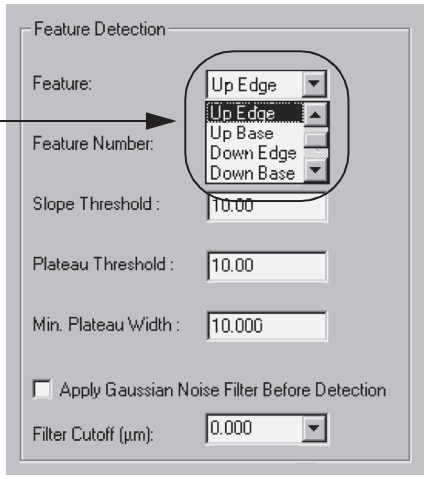
Feature	Description
None	No feature detection is being used.
UpEdge	At the trailing edge of a feature rise, it is the point at which the trace begins the plateau. (See *Figure 3.47*.) **NOTE**: This point location can be modified by using **Distance to Edge** parameter in the **General Parameters** Window.
UpBase	At the trailing edge of a plateau, it is the point at which the trace begins to turn upward. (See *Figure 3.47*.)
DownEdge	At the trailing edge of a plateau, it is the point at which the trace begins to turn downward. (See *Figure 3.47*.)
DownBase	At the trailing edge of a feature decline, it is the point at which the trace begins the plateau. (See *Figure 3.47*.)
Convex	This is the point at the apex of a convex feature. (See *Figure 3.48*.)
Concave	This is the point at the apex of a concave feature. (See *Figure 3.48*.)

Selecting a feature for detection:

1. Click on the menu arrow next to the variable box to display its menu.
2. Click on the desired feature to select it. If necessary, use the scroll bar to reveal other features. (See *Figure 3.49*.)

Figure 3.49 *Feature - Feature Detection - Recipe Editor*

Feature Detection allows the user to choose from six feature option (convex and concave not shown). Click on the menu arrow to display the menu. Click on the desired feature to choose it.



Feature Number

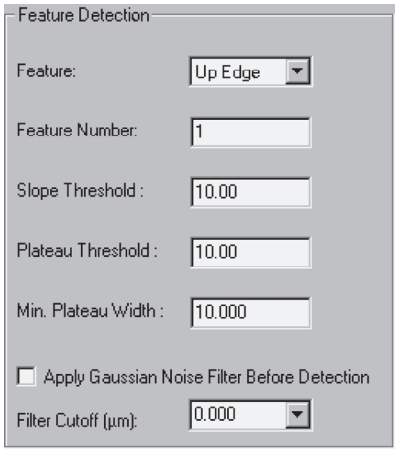
If there are multiple edges detected in the scan, **Feature Number** provides a way to select a specific edge for detection. (See *Figure 3.50*.)

Changing the **Feature Number:**

Double-click in its variable box to highlight the current number and type in the new number. (Use a whole number. **1** is Default)

Figure 3.50 *Detection Variables - Feature Detection - Recipe Editor*

Detection parameters are changed by clicking in the appropriate variable box to highlight the current number. Then type in the new number.



Slope Threshold

This factor sets the value at which any rise or fall in a trace is considered to be a slope, not just part of the roughness or noise. This means that the **Slope Threshold** defines a point at which the system recognizes a trace line as following or preceding an ***edge***, ***convex*** or ***concave*** point. (See *Figure 3.50*.)

Changing the **Slope Threshold:**

Double-click in its variable box to highlight the current number and type in the new number:

- Use values between 0 and 50.000
- Default is 10.000 for a step and 1.000 for an apex point. These values are sufficient for most scans above 200 Å in height.

NOTE: For very noisy scans where the system is having difficulty detecting the feature, decrease the Slope Threshold. A value as low as 5.00 can work well.

Plateau Threshold

This factor affects the precise horizontal location calculated for an edge or arc point. This parameter allows for the positional adjustment of the point to the left or right. (See *Figure 3.50*.)

Changing the **Plateau Threshold:**

Double-click in its variable box to highlight the current number and type in the new number:

- Use values between 0 and 50.000
- Default is 10.000 for a step and 0.000 for an apex point. These values are sufficient for most scans above 200 Å.

NOTE: When comparing data from scans of identical features, find a value that works and then use it consistently. Data is changed when differing **Plateau Threshold** numbers are used.

Min. Plateau Width

Minimum Plateau Width defines the minimum horizontal distance between rising and falling edges (or falling and rising edges). This is used in feature detection to identify true features.

Changing the Min. Plateau Width:

Double-click in its variable box to highlight the current number and type in the new number:

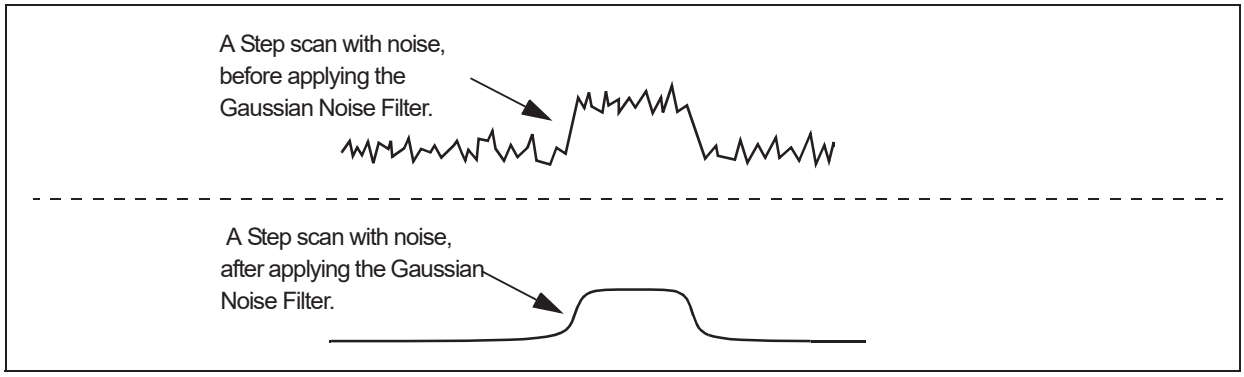
- Use values between 0.005 and 1000.00 µm (0.0002 to 39.3701 mil)
- Default is 10 µm.

NOTE: This is very dependent on which **Feature** is chosen for detection and which **Feature Number** is used.

Apply Gaussian Noise Filter Before Detection

This is only used to filter out unwanted noise so the feature detection can more easily detect designated features. (See *Figure 3.51*.) ***It does not apply the result to scan data***. For use of the **Gaussian Filter** with scan data, see *Filters* on page 3-50.

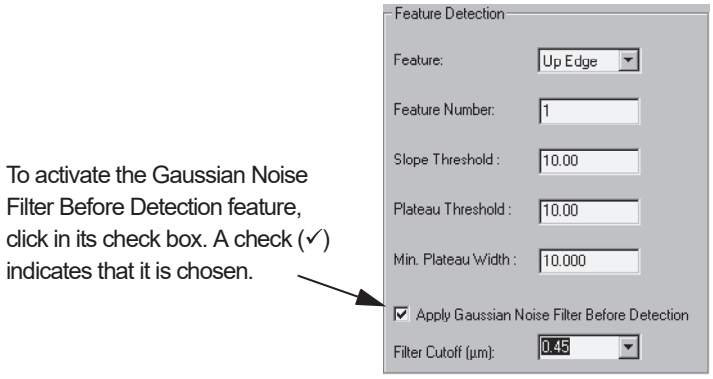
Figure 3.51 *Scan Noise and the Gaussian Noise Filter*



To activate this feature

Click in the empty check box to put a ✓ in it. (See *Figure 3.52*.) Then set the **Filter Cutoff (µm)** size.

Figure 3.52 *Activating the Gaussian Noise Filter*



Filter Cutoff (µm)

This option is only activated when there is a check in the **Apply Gaussian Noise Filter Before Detection** check box. (See *Figure 3.52*.) The number to be entered is in microns. This determines the noise level that is filtered out.

For an in depth discussion on filters, see *Filters* on page 3-50.

Changing the Filter Cutoff

1. 1. Ensure that a Feature has been chosen.
2. 2. Click on the menu arrow to display its menu.
3. 3. Click on the desired cutoff filter setting.

NOTE: A Feature must be chosen in order for the Gaussian Filter to become active. If **None** is showing in the **Feature** variable box, the Gaussian option is grayed out. To activate it, select a feature.

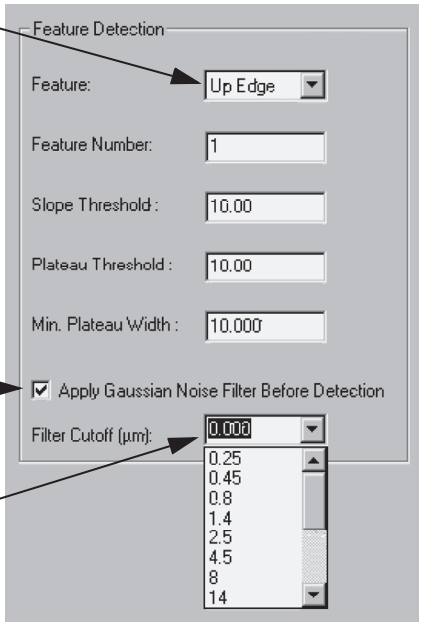
The Filter Cutoff range is from 0.25 through 800 µm. Only established variables can be chosen.

Figure 3.53 *Filter Cutoff Menu*

Step 1 In order for the **Apply Gaussian Noise Filter Before Detection**, a Feature must be chosen. The filter is not available unless there is a feature chosen.

Step 2 After a Feature is chosen, put a check (✓) in the check box by clicking in it.

Step 3 Click on the menu arrow to display its menu. Click on the desired cutoff filter setting.



Filters and Cursors (Only for 2D Scans)

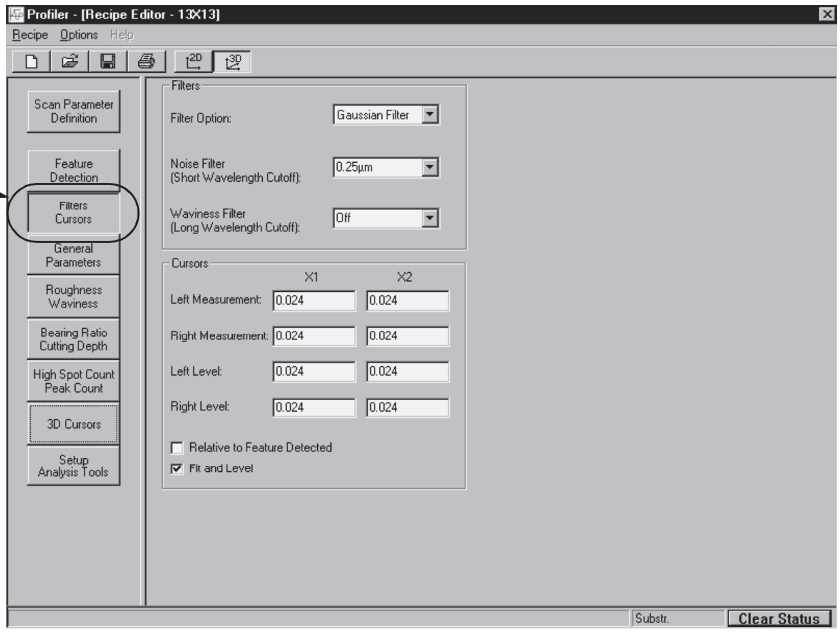
Filters

Two filters are available for removing noise from scan data, either as the scan is taking place, or after the scan occurs but before the data is saved. The oldest filter is the RC Filter. **RC** stands for Resister Capacitor Filter. The second, the **Gaussian Noise Filter**, is the best of the two and is generally chosen when a filter is required.

Click on the **Filters/Cursors** button to display the **Filters/Cursors** parameters.

Figure 3.54 *Filters/Cursors Parameters - Recipe Editor*

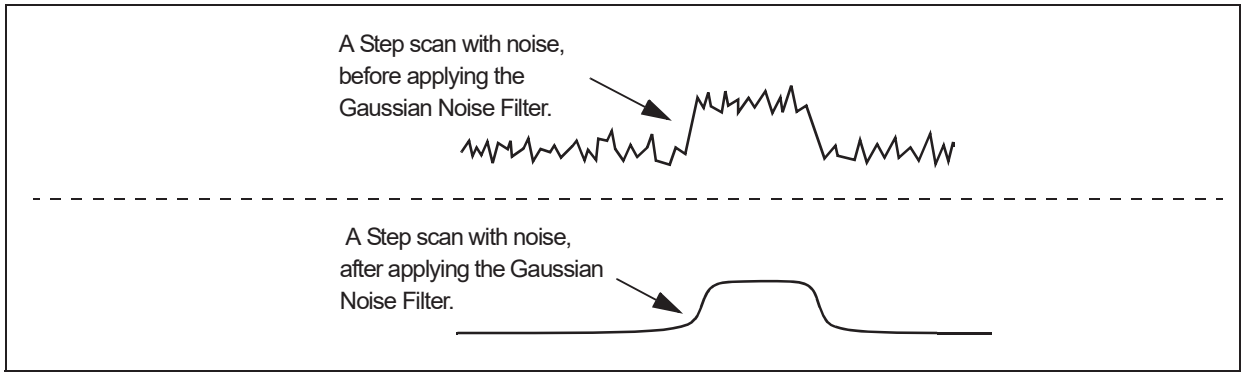
The **Filters/Cursors** parameters window is displayed by clicking on the **Cursors/Filters** button in the Recipe Editor.



Gaussian Filter

This option is used to filter noise out of a scan. Application of this filter can be made to the scan data as it is being generated (during the scan) or after the scan is complete but ***before the data is saved***.

Figure 3.55 *Scan Noise and the Gaussian Noise Filter*

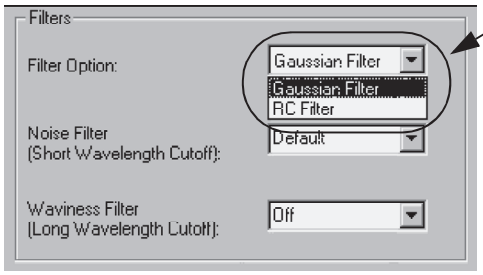


The illustration in *Figure 3.55* shows the effect of applying the **Gaussian Noise Filter** to a scan. This filter can be set to filter out noise from 0.25 to 800 µm, as is evident in the available wavelength values in the **Noise Filter** drop-down menu.

To select the Gaussian Filter: (See *Figure 3.56*.)

1. Click on the **Filter Option** menu arrow to display its menu.
2. Click on **Gaussian Filter**.

Figure 3.56 *Filters Parameters - Filter Option Menu*



Two Filter options are available for use in filtering out noise. The newest and best is the **Gaussian Filter**. The **RC Filter** might be desirable if scanned data is to be compared with older scans that were made on Tencor DOS based profilers using the **RC Filter**.

RC Filter

This is an older version noise filter. It was used with Tencor profilers before the Gaussian Noise Filter was introduced. If the scans performed using this recipe are going to be compared to scan performed by other ***Tencor DOS based profilers*** using the **RC Filter**, then the use of the **RC Filter** helps in scan to scan correlation.

Selecting the RC Filter: (See *Figure 3.56*.)

1. Click on the menu arrow next to the variable box to display its menu.
2. Click on **RC Filter**.

Noise Filter

The **Noise Filter** is a *Short Wavelength Cutoff* filter. This is an adjustable software filter used to reject short wavelength components of scan data. When used with the **Waviness Filter** (*Long Wavelength Cutoff*), it also isolates band passes for wavelengths. See *Setting the Short-Wave Filter Cutoff Values* on page 8-35 for more information about using the cutoff filters in surface analysis.

Selecting the Short Wavelength Cutoff: (See *Figure 3.57*.)

1. Click on the **Noise Filter** menu arrow to display its menu.
2. Click on the desired Shortwave Cutoff.

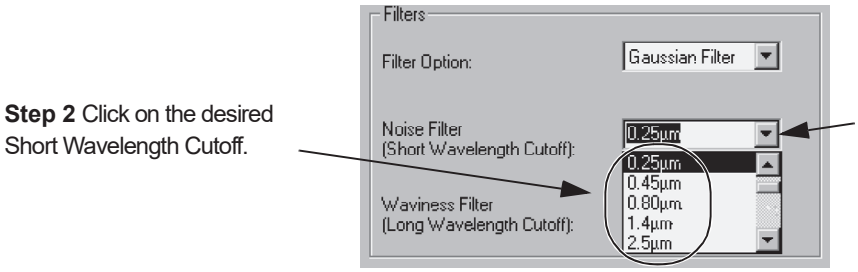
NOTE: The availability of cutoffs is dependent on the scan speed. A short wavelength cutoff cannot be entered if it is longer than the currently selected long wavelength cutoff, or shorter than the value of the analog cutoff.

Short wavelength cutoff ≤ Long wavelength cutoff

Short wavelength cutoff ≥ Analog cutoff

NOTE: For scan speeds greater than 5 µm/s, the shortest short wavelength cutoff selection turns the short wavelength filter completely off. If subsequent changes to the scan speed or scan length cause the short wavelength cutoff setting to become invalid, the cutoff is automatically changed to the nearest available valid value (possibly the default).

Figure 3.57 *Filters Parameters - Noise Filter Menu*



Waviness Filter

The **Waviness Filter** is the *Long Wavelength Cutoff* filter. It is an adjustable software filter to separate long wavelength components of scan data. When used with the Short Wavelength Cutoff, it also isolates band passes for wavelengths.

Two types of Long Wavelength Cutoff filters are used:

- Gaussian, the best filter for use with Windows based systems.
- RC, used on older DOS based Tencor systems. Use this filter when comparing new data with data obtained using the RC filter on a DOS based system. This provides uniformity for comparison basis

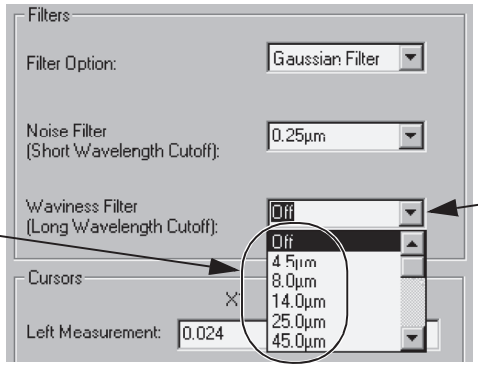
To Select the **Long Wavelength Cutoff**: (See *Figure 3.58*.)

1. Click on the **Waviness Filter** menu arrow next to display its menu.
2. Click on the desired **Long Wavelength Cutoff** value.

NOTE: The availability of cutoffs is dependent on the scan speed. The systems prevents the accidental entry of a long wavelength cutoff that is shorter than the currently selected short wavelength cutoff or the value of the analog cutoff.

If subsequent changes to the scan speed or scan length cause the long wavelength cutoff setting to become invalid, the cutoff is automatically changed to the nearest available valid value.

Figure 3.58 Filters Parameters - Waviness Filter Menu



Step 2 Click on the desired Long Wavelength Cutoff value.

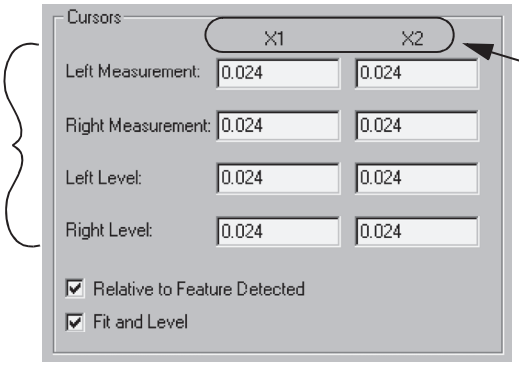
Step 1 Click on the menu arrow to display the cutoff menu.

Cursors

Cursors are used for two general purposes:

- **Measurement Cursors** are used to gather data either between the two sets of cursors or within the boundaries of the cursor itself.
- **Leveling Cursors** are used to level the data points in the trace so the trace features fairly represent the actual scanned surface.

Figure 3.59 Cursor Parameters - Recipe Editor



Cursor parameters can be changed using the screen variable boxes by clicking in the appropriate variable box to highlight the current number. Then type in the new number.

The limits of the cursor boundary are displayed in the X1 and X2 columns for the various cursors.

Notice that the cursor parameters have not been set in the illustration. They are all at a single point on the trace.

Each cursor has limits that can be set. The limits of the cursor boundary are displayed in X1 and X2 in the **Cursors** parameters box. *The cursor limits are set relative to the starting point of the scan.* These values can be set in the window by clicking on the current value in the variable box and typing in the new value.

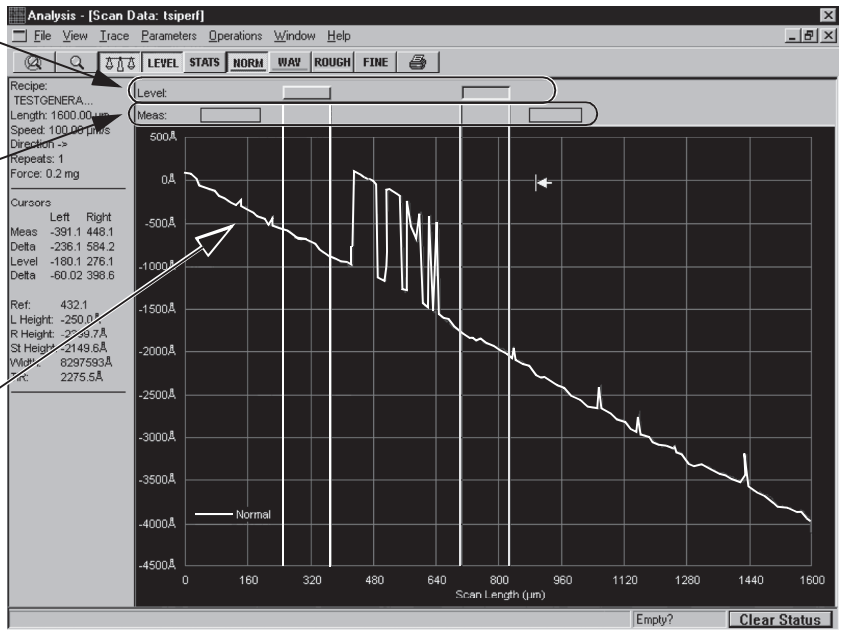
The easiest way is to set the cursors is in the analysis screen, after the scan, using the click and drag procedure. The procedure is described in the following discussion. (For more information on leveling cursors see *Leveling Cursors* on page 3-55.)

Figure 3.60 *Analysis Screen with Trace in Need of Leveling*

The Leveling Cursors are the top set

The Measurement Cursors are the bottom set.

The trace is shown running from the top left to the bottom right of the screen. This clearly shows the need for data leveling.



Leveling Cursors

In general, the most effective way to set the **Leveling Cursors** is in the **Analysis** screen by clicking and dragging them into position. When they are in position, use the CALC procedure (see Step 4 on page -58) to enter the new **Cursors** variables. By visually positioning the cursors, the leveling positions are correct for the actual scan.

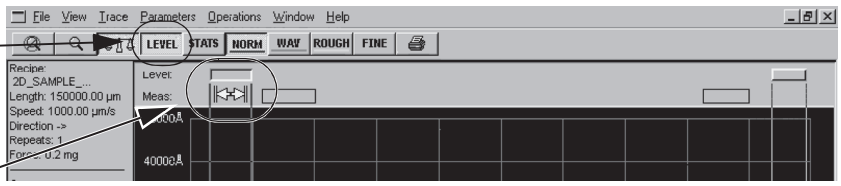
Setting the Leveling Cursor positions:

1. After the scan is complete, the **Analysis** screen is displayed. Click on **LEVEL** to activate the Leveling Cursors. (See *Figure 3.61*.)
2. Reposition the leveling cursors using the following procedure.

Figure 3.61 *Leveling Cursors*

Step 1 To reposition cursors, click on the **LEVEL** button in the tool bar to activate the Leveling Cursors.

Step 2 When activated, click and hold in the gray area containing the cursor boundary box, an drag the cursors to the new position.



Notice the double arrow associates with the cursor that is active, the one that moves when drug.

a. Click on the **LEVEL** button in the tool bar. This activates the Leveling cursors. The active cursor header is displayed as a 3D rectangle. The cursor header being moved is indented while the other cursor is in relief. The Measurement cursor heads appear as 2D line boxes. (See *Figure 3.61*.)

b. As the track ball cursor approaches one of the active cursor heads, the cursor head changes appearance to indented and the track ball cursor appears as a double arrow as shown in *Figure 3.61*.

Click and hold on the cursor that is to be moved. Drag it to the desired position, using the track ball to move it. Release the mouse button when the cursor is in position.

3. When the cursor is in position, set each cursor boundary using the following procedure:
   a. Move the track ball cursor down into the black scan trace screen. The boundary that the arrow is pointing at is the one that is moves. (See *Figure 3.62*.)
   b. Click and hold the mouse button while using the track ball to drag the boundary into position for leveling the scan. Release the mouse button when the boundary is correctly positioned.

NOTE: Both cursors should be positioned on the same X-plane. The cursor boundaries should be positioned on the same plain, avoiding noise peaks or valleys. This generally gives a flat scan trace.

   c. Repeat **Step 1** and **Step 3** for the remaining cursor.
4. Click on the **LEVEL** button to level the trace. (See *Figure 3.62*.) This cause the trace to be leveled and displays the trace with the Measurement Cursors active. (See *Figure 3.64* for a leveled trace.)

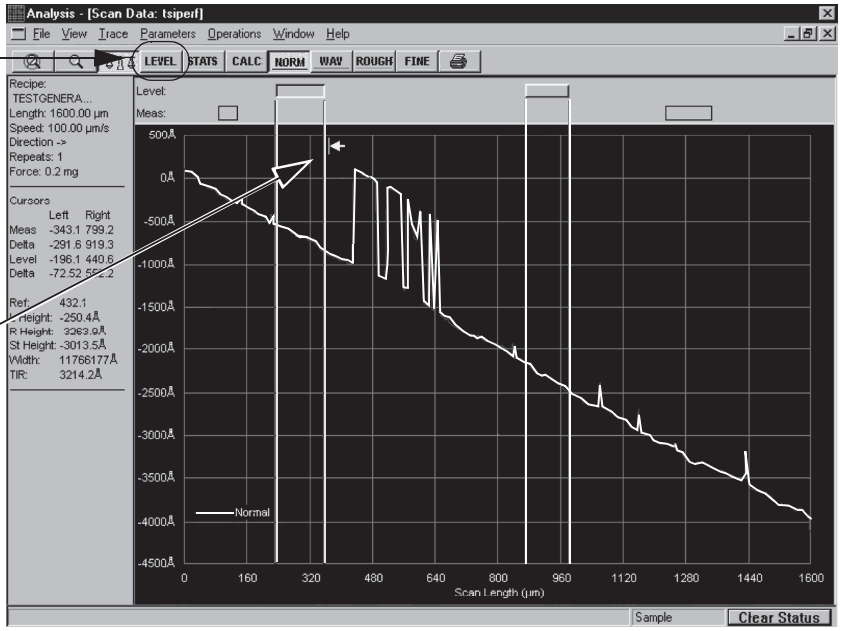
Figure 3.62 *Cursor Boundary Setting on Unleveled Trace*

Step 4 After Leveling cursors have been set, click on **LEVEL** to level the trace.

Step 3 When the Leveling Cursor is placed in the general area that it is to be used, move the track ball cursor down into the black trace screen to position the cursor boundaries.

A single arrow points at the cursor boundary that is to be adjusted.

Click and hold the mouse button and use the track ball to move the cursor boundary into place.

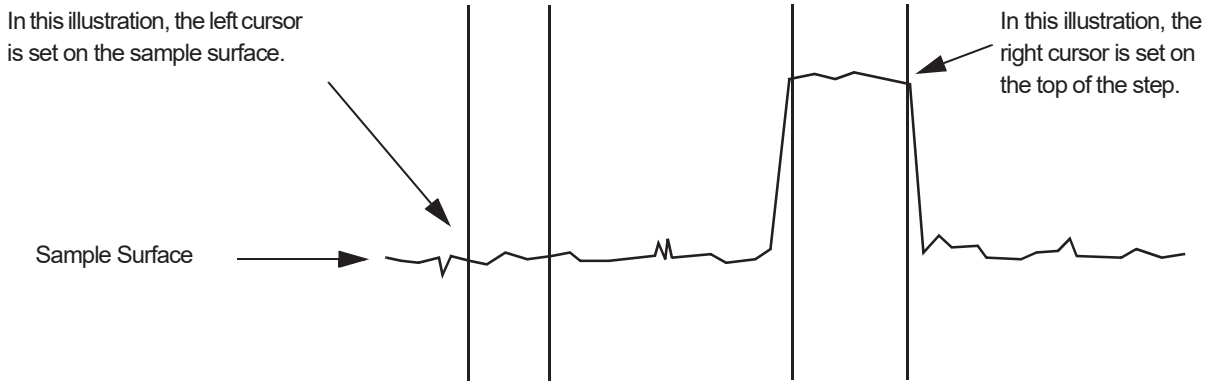


Measurement Cursors

The Measurement cursors are used to measure various attributes of the scan. Some measurements are obtained between the cursors, while others are made within the boundary of a single cursor.

1. It is important to set the measurement cursors to accurately measure the desired feature. In *Figure 3.63* the left cursor is set on the sample surface with the cursor borders positioned to measure a relatively flat trace segment. The right cursor is positioned to detect the height of the step being measured. (See *Figure 3.63*.)

Figure 3.63 *Setting Measurement Cursors*

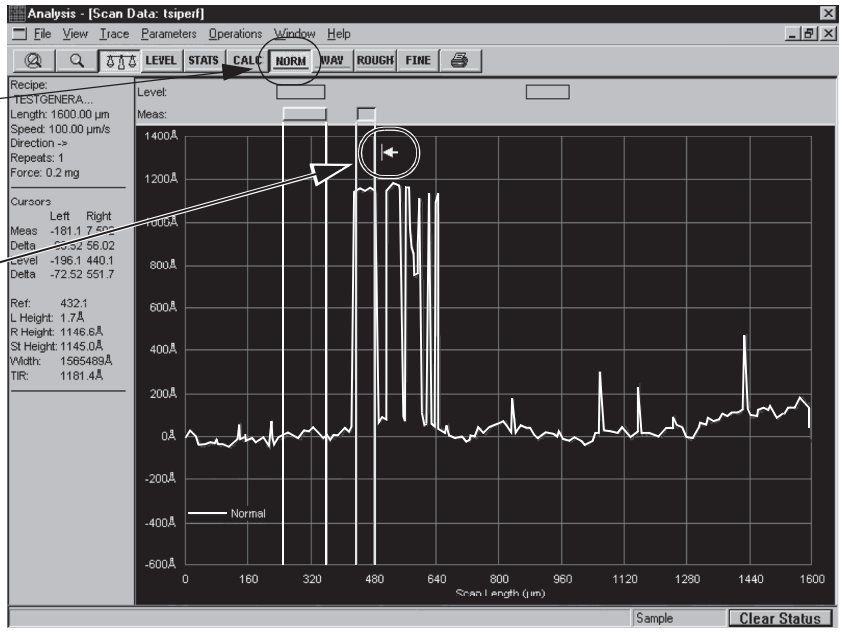


   a. Click on the **NORM** button in the tool bar. This activates the Measurement cursors. The Measurement cursor header appears as a 3D rectangles. The Leveling cursors appear as 2D line boxes. (See *Figure 3.64*.)

Figure 3.64 *Measurement Cursor on Level Trace*

Step 1 The leveled trace appears with the Measurement Cursors active. If the **Measurement Cursors** are not active, click on the **NORM** button in the tool bar.

Move the cursor into the graph area and position it next to the cursor boundary that is to be moved. It appears as an arrow.



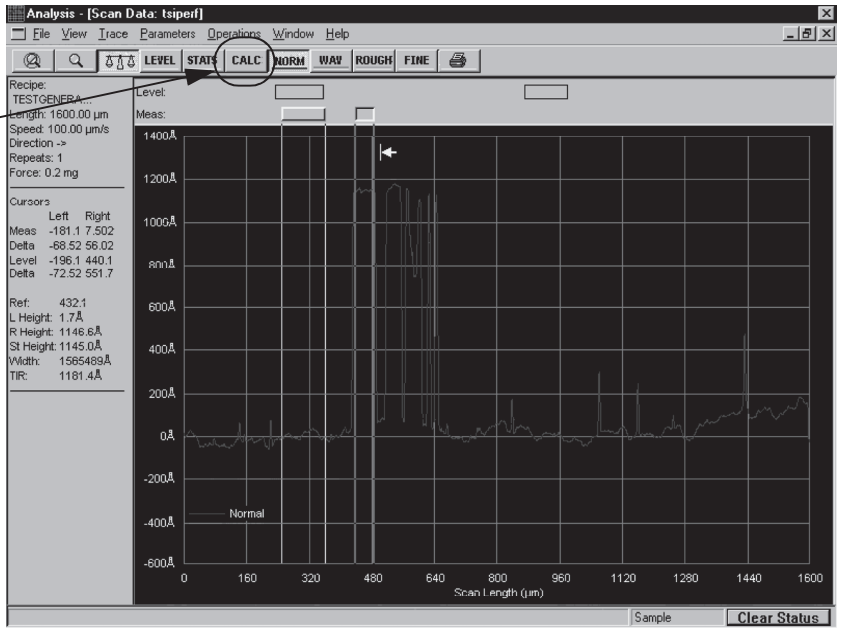
b. As the track ball cursor approaches one of the active cursors, the cursor header changes to appear indented and the track ball cursor appears as a double arrow as shown in *Figure 3.61*.

   Click and hold on the cursor that is to be moved. Drag it to the desired position using the track ball to move it. Release the mouse button when the cursor is in position.

2. When the cursor is in position, set each cursor boundary using the following procedure:
   a. Move the track ball cursor down into the black scan trace screen. The boundary that the cursor arrow is pointing at is the one that moves. (See *Figure 3.64*.)
   b. Click and hold the mouse button while using the track ball to drag the boundary into position for its intended measurement in the scan. Release the mouse button when the boundary is correctly positioned.
   c. Repeat **Step 1** and **Step 3** for the remaining cursor.
   d. Click on the **LEVEL** button to level the trace.
3. When the trace has been leveled and the Measurement cursors have been placed, click on **Operations** to display its menu.
4. When the trace has been leveled and the Measurement cursors have been placed, click on the **CALC** button to cause the system to recalculate the data with new cursor positions. The new positions are saved as part of the recipe. (See *Figure 3.65*.)

Figure 3.65 *Analysis Screen CALC Button*

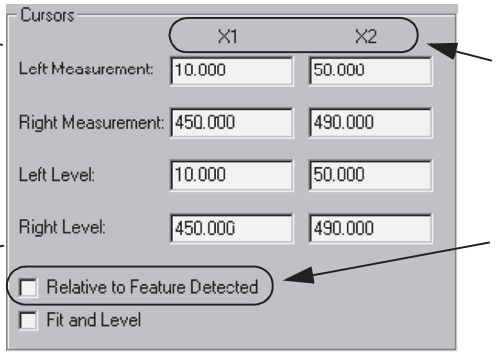
Step 4 Click on the **CALC** button to recalculate the data with new cursor positions.



The **Recalculation** process places the cursor **limits** in the **Cursors** window of the **Recipe Editor**. (See *Figure 3.66*.)

Figure 3.66 *Cursor Parameters - Recipe Editor*

Cursor parameters (limits) are automatically changed when the **CALC** button is clicked in the **Analysis** screen (*before the data is saved*).



The limits of the cursor boundary are displayed in the X1 and X2 columns for the various cursors.

When this box is checked, the feature takes on the "0" position and the cursors are set with negative numbers to the left and positive to the right.

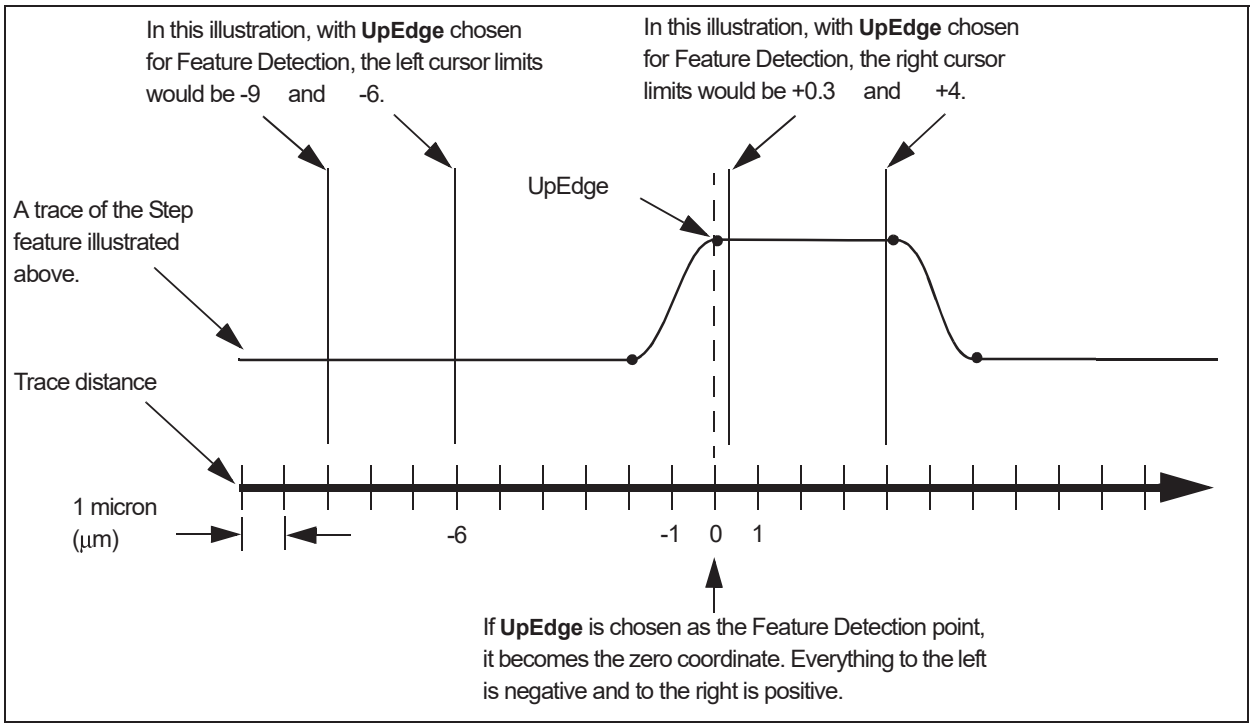
Relative to Feature Detected

When there is a check (✓) in its checkbox, the cursor limits are set relative to the feature that is defined in the **Feature Detection** parameters window in the **Recipe Editor**. (See *Feature Detection (Only for 2D Scans)* on page 3-43.) The feature becomes the **0** point (the origin of the new coordinate system), with the points to the left being negative and those to the right being positive. (See *Figure 3.67*.)

The cursors are set in the same way described in Step 1 on page -55 through Step 3 on page -56. The system automatically places the measurement and leveling cursors relative to the actual feature instead of relative to the starting point of the scan.

NOTE: If **Relative to Feature Detected** is not checked, there should be no negative numbers in any cursor position because the start of the scan is the "0" point.

Figure 3.67 *Measurement Cursors - Relative to Feature Detection*



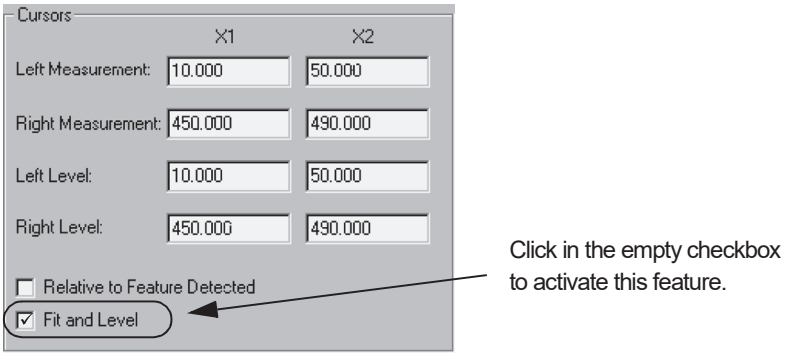
F*it and Level*

This option is designed to remove a secondary curvature from the overall trace of a curved surface. Features should then appear relative to a flat surface.

Selecting the Fit and Level option

- Click in the empty check box to put a check (✓) in it.

Figure 3.68 *Cursor Parameters - Recipe Editor*



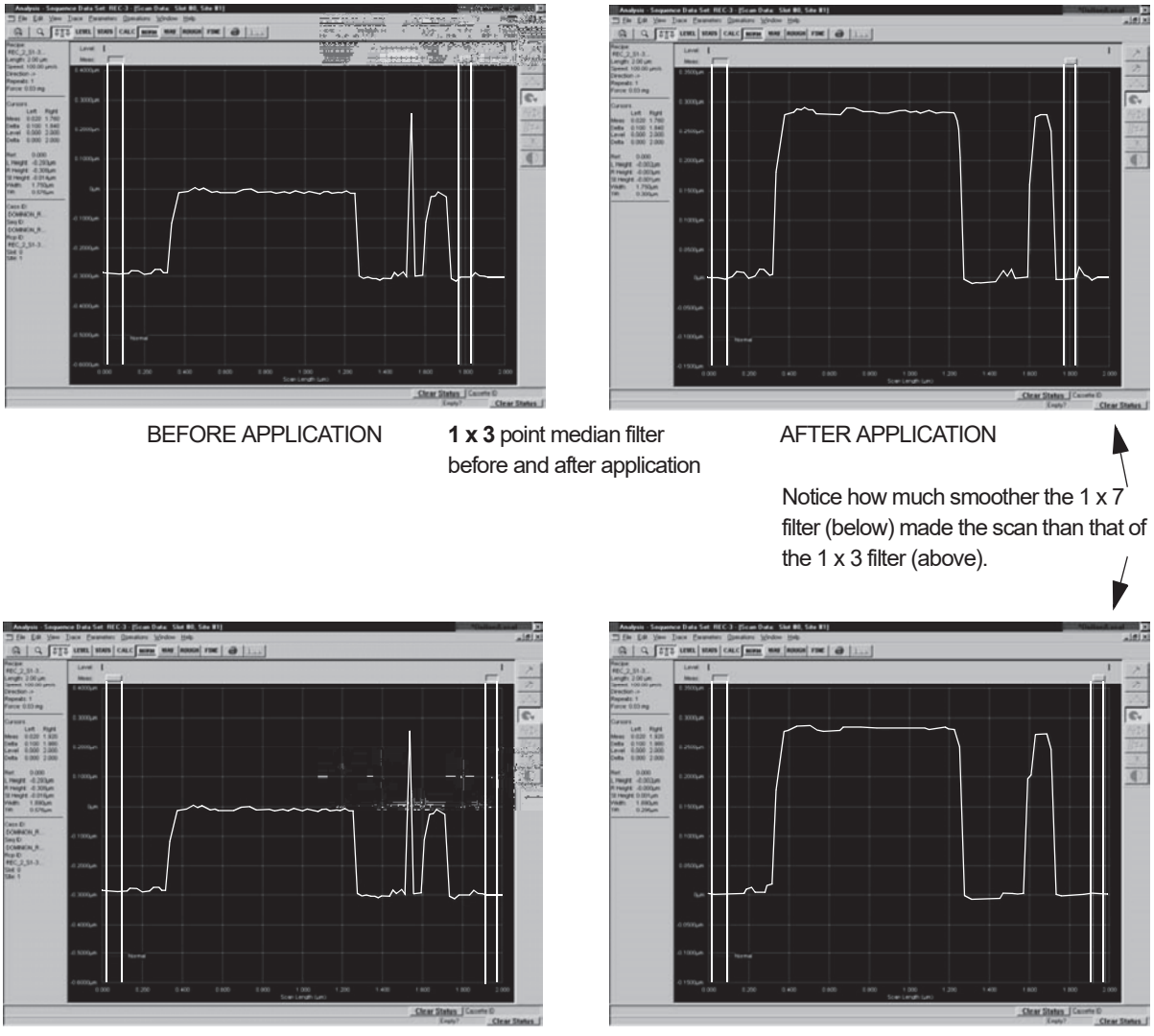
Median Filter for 2D and 3D Data

This filter can be chosen as part of the recipe to help filter out spikes from environmental noise and particulate contamination. A median filter can be turned on before the scan, allowing the system to filter the data before the first viewing. It can also be used on saved data. With the data open in the Analysis screen, the saved data from single scans and sequences can be changed by opening the recipe used to create the scan from the Analysis screen, and changing the filter size in that recipe.

The median filter is used for both 2D and 3D data, with each type having its own menu of kernel sizes for the filters being applied to the data. When the filter is applied before the scan, the data is filtered and permanently changed.

The median filter works as a smoothing tool, taking out glitches and smoothing the trace surface in direct proportion to the size of the kernel. The median if found for the effected points in the kernel and is applied to data. The larger the kernel, the greater the smoothing effect on the data. In general, the smaller the kernel (i.e., the 1 x 3 for 2D and the 3 x 3 for 3D), the less the data is manipulated.

Figure 3.69 *Median Filter Application in Glitch Removal*



The median filter is a major component of the Glitch Removal process used on data in the Analysis screen for both 2D and 3D data. (See *2D Glitch Removal* on page 8-40, and *Activate 3D Glitch Removal Tool.* on page 9-17.)

The available filter sizes (kernels) for 2D data are: 1 x 3, 1 x 5, and 1 x 7 points.

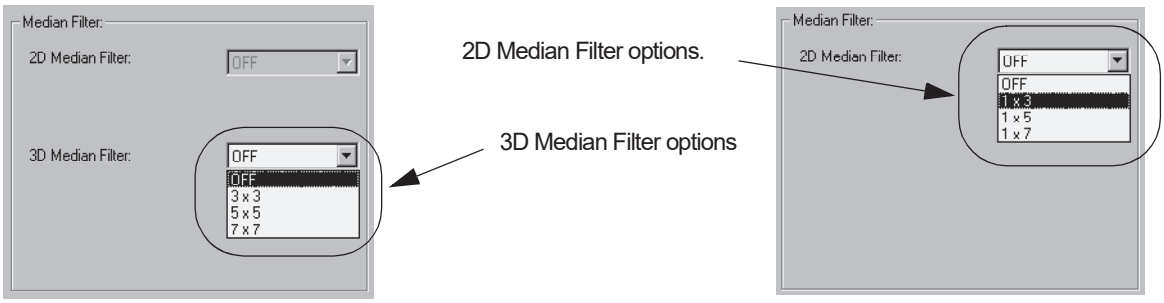
The available filter sizes (kernels) for 3D data are: 3 x 3, 5 x 5, and 7 x 7 points.

Set or Change Median Filters for Saved Data

To add a filter or change the filter size on existing data, use the following procedure:

1. From the Catalog Screen, with either the Scan Data or Sequence Data catalog open, open the data set by double-clicking on it. The Analysis screen opens.
2. From the Analysis screen, click on **Edit** to display its menu.
3. Select **Recipe**. This opens the recipe used to generate the data.
4. Click on **Filters/Cursors** to display the Filters and Cursors parameters.
5. Click on the menu-arrow for either the 2D or 3D Median Filter to display the options. (See Sc*Figure 3.70*.)
6. Choose the required filter size for the 2D or 3D data.

Figure 3.70 *2D and 3D Median Filter Options*



7. Click on the Analysis screen icon in the tool bar to return to the Analysis screen for the affected data.

Setting Median Filter Prior to a Scan or Sequence

To set the **median filter** for 2D or 3D scans, either single scan or for use in a sequence, prior to using the recipe, choose the required median filter while setting the other recipe parameters. If the recipe is already a part of a sequence, the recipe can also be opened from the sequence and the median filter added or changed prior to running the sequence.

For additional use of the median filter see *2D Glitch Removal* on page 8-40, and *Activate 3D Glitch Removal Tool.* on page 9-17.

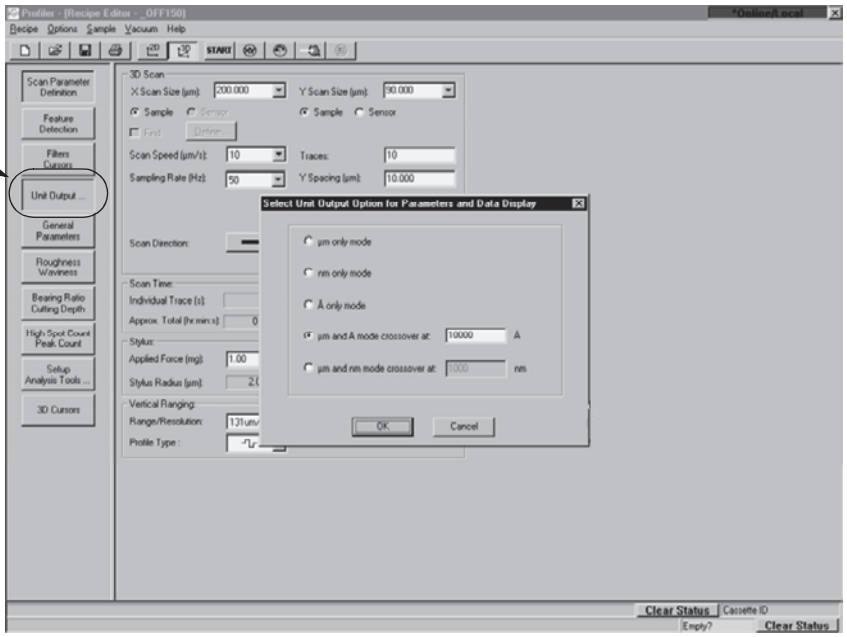
Unit Output

Unit Output is designed to give the user an opportunity to determine units of output for the parameters calculated and to set automatic crossover values for unit changes. The options here let the user choose the units for the 2D graphical display through the recipe that is used to generate the scan. This option does not change the internal representation of data or the statistical parameters which continues to be in Angstroms.

1. Click on **Unit Output** in the Recipe screen window buttons to open the Unit Output parameters dialog box. (See *Figure 3.71*.) This dialog box is where units are chosen for statistical data and graphic presentation.

Figure 3.71 *Recipe Screen with Unit Output Dialog Box*

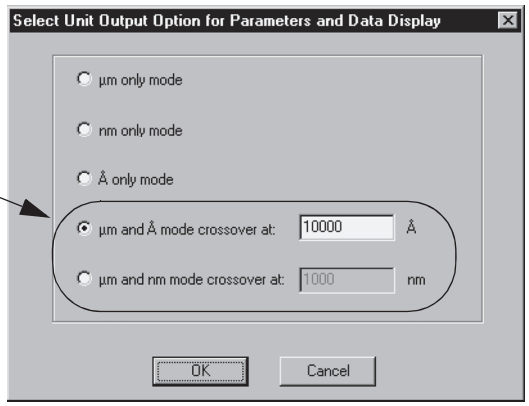
Click on Unit Output to open its dialog box.



2. Choose the desired units for statistical data reporting and graphic presentation by clicking to place a dot in the radio button. (See *Figure 3.72*.)
3. If one of the bottom two choices are made, the crossover value must be entered in the variable field. (See *Figure 3.72*.)

Figure 3.72 *Unit Output Dialog Box*

Choose the desired unit of output for graphics and calculated parameters. Make sure to enter the crossover values if either of the late two options are chosen.



To accept changes, click **OK**. To reject changes and retain current values, click **Cancel**.

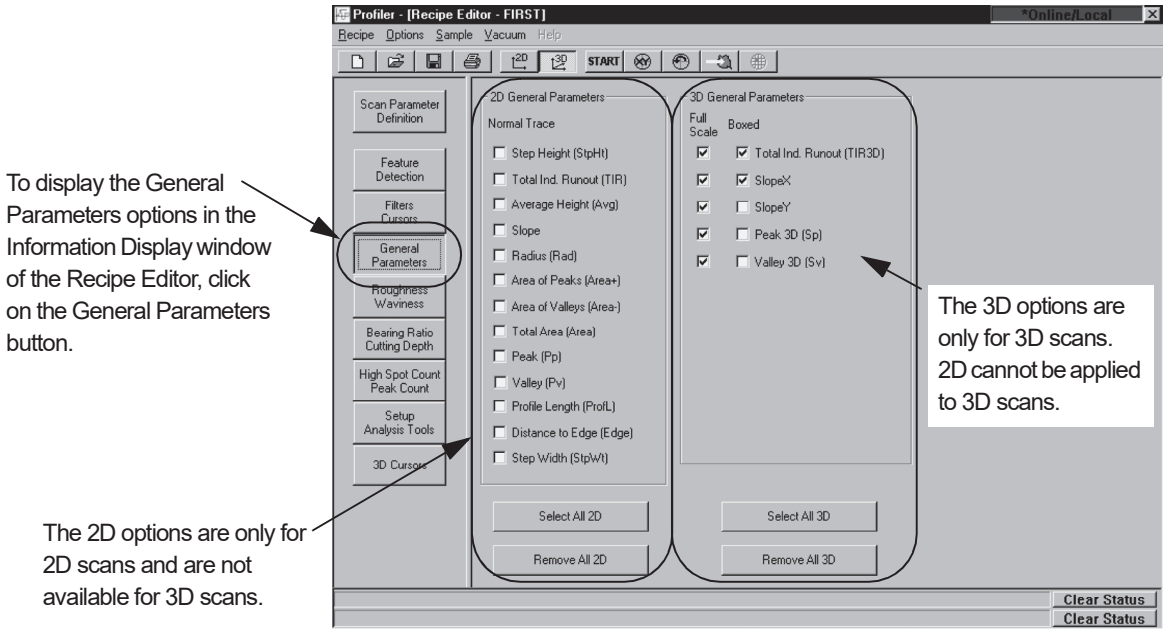
4. Click **OK** when all changes are complete, to accept the new values.

General Parameters

The **General Parameters** window contains a variety of surface analysis calculations which are performed on the scan data when the options are chosen before the scan, or if they are applied to the scan data after the original data has been saved.

For each surface analysis option chosen, a post scan calculation is performed and displayed on the Analysis screen.

Figure 3.73 *General Parameters - Recipe Editor*



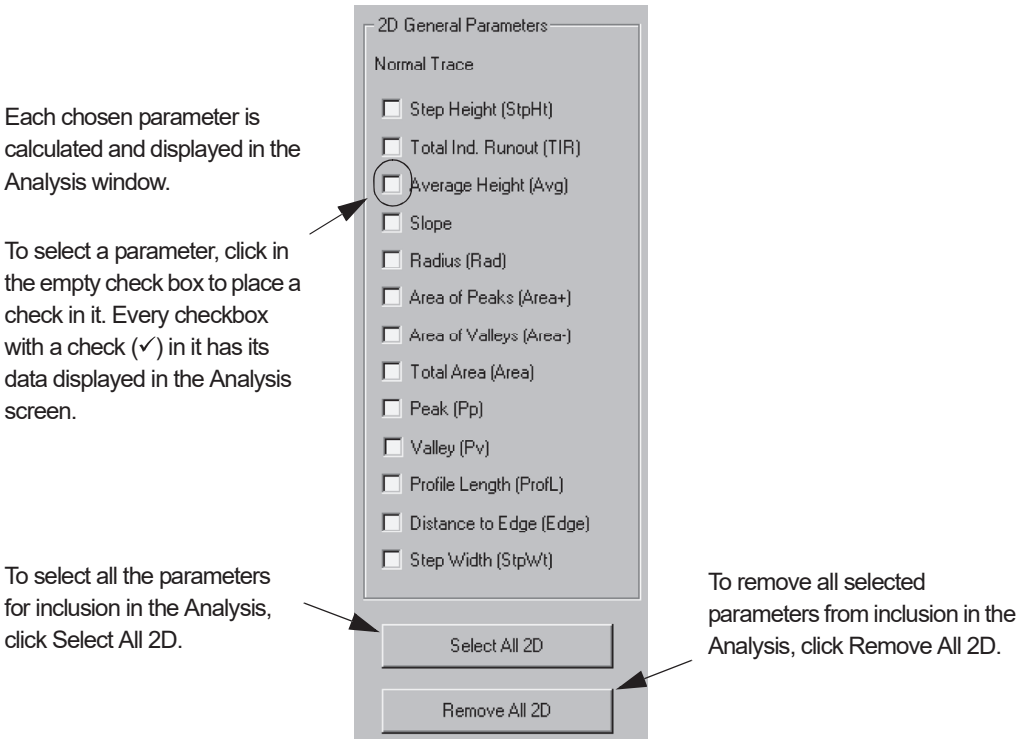
To access the **General Parameters** window, click on the **General Parameters** button in the **Recipe Editor** screen. (See *Figure 3.73*.)

2D General Parameters (Normal Trace)

These parameters represent calculations that are performed using the data from a scan. If the options are chosen before the scan is performed, and are part of the *scan recipe*, the calculations are automatically performed by the software and displayed in the Analysis screen upon completion of the scan. Parameters from the 2D General Parameters are for single trace analysis, and as such, are not available for 3D scan data analysis. (See *Analyzing 2D Scan Data* on page 8-1.)

Each parameter is discussed below. (See *Figure 3.73*.)

Figure 3.74 *2D General Parameters*



Adding 2D General Parameters to the Analysis

- In the **2D General Parameters** options box, click in the checkbox of any option (see *Figure 3.79*) to include them in the current recipe and display each data value in the **Analysis** screen. A check (✓) in the checkbox activates the parameter.
- Add all the **2D General Parameters** to the Analysis by clicking **Select All 2D** at the bottom of the list. This puts a check (✓) in the checkbox of all parameters.
- Remove all checked parameters from the **2D General Parameters** by clicking **Remove All 2D** at the bottom of the list. This removes all checks from any chosen parameters

Table 3.24 *2D General Parameters*

Parameter	Description
Step Height (StpHt)	The difference in height between the left and right measurement cursors positions. Each cursor position is an average of the area between the cursor boundaries. The difference is between these averages.
Total Indicator Runout (TIR)	The difference between the highest and lowest points in the scan.
Average Height (Ave)	The average height of all data points between the measurement cursors relative to the leveled baseline. (ANSI)
Slope	The ratio of the difference in vertical positions to the difference in horizontal positions of the measurement cursors. The slope is reported as an angle in degrees.  **NOTE:** The position of each cursor is taken to be the horizontal midpoint of each delta cursor band, and the data value at this location is the average of the vertical values within these bands. (ANSI)
Radius	The distance from the center of curvature of the profile arc (assuming a circular profile within the sampling length) to the profile. The measurement cursors define two points of a circular arc. A *least squares* calculation is performed on the points between the cursors. The normal trace should not be leveled unless definite level reference points exist.
Area of Peaks (Area+)	The total area bounded by the leveled baseline and the profile where it rises *above* the baseline. (ANSI)
Area of Valleys (Area-)	The total area bounded by the leveled baseline and the profile where it descends *below* the baseline. (ANSI)
Total Area (Area)	The sum of **Area of Peaks** and **Area of Valleys**. The delta cursors are not used. (ANSI)

Table 3.24 *2D General Parameters (Continued)*

Parameter	Description
Peak (Pp)	Maximum Z value, measured relative to the leveled reference line, between the left and right measurement cursors.
Valley (Pv)	Minimum Z value, measured relative to the leveled reference line, between the left and right measurement cursors.
Profile Length (ProfL)	The length that would be obtained from drawing out the profile in a straight line. (ANSI)
Distance to Edge (Edge)	Depending on the parameters settings in **Feature Detection**, this distance is either: ◆ The distance between the beginning of the scan and the first rising or falling edge of a profile feature; or ◆ The distance between the beginning of the scan and the first concave or convex arc of a profile feature. **NOTE:** This parameter is independent of the cursor positions. It is based on the feature detection parameters.
Step Width (StpWt)	The distance between the first rising edge of an upward step and the falling edge that follows, or the first falling edge of a downward step and the rising edge that follows. This value is meaningless for a convex or concave arc.

3D General Parameters

These parameters represent calculations that are performed using the data from a scan. Only three General Parameters exist for 3D scans. (See *Figure 3.75*.) If the options are chosen before the scan is performed, and are part of the *scan recipe*, the calculations are automatically performed by the software and displayed in the Analysis screen upon completion of the scan. Parameters from the 2D General Parameters are for single trace analysis and as such are not available for 3D scan data analysis. The options can be applied to live or saved data.

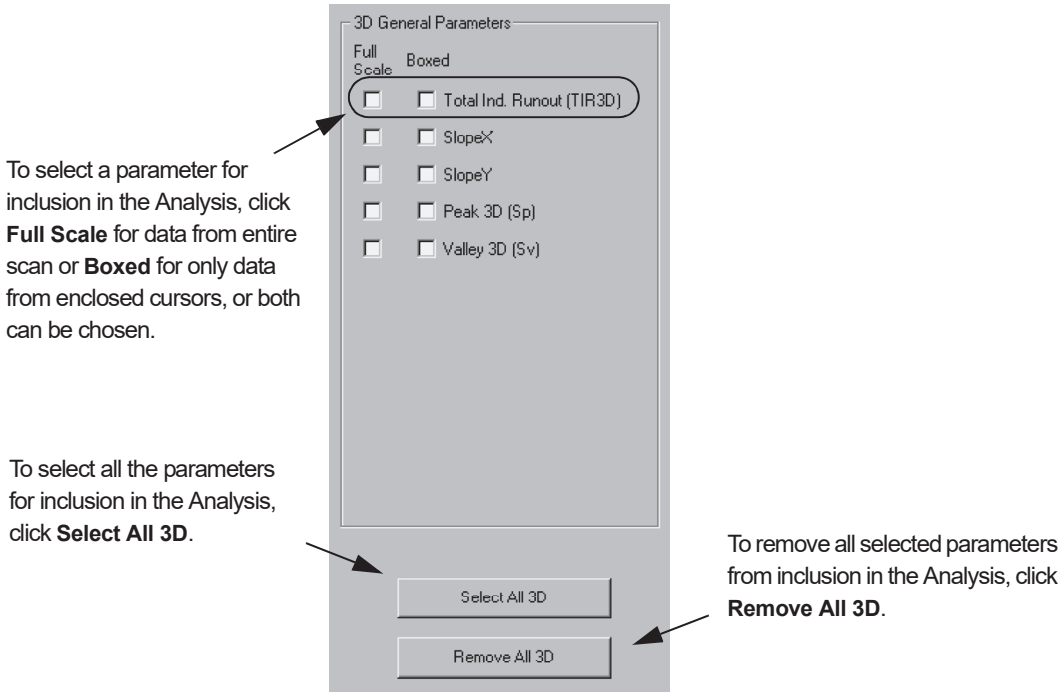
Each parameter option can be calculated in two different ways:

- **Full Scale:** With this checkbox selected, the parameter are calculated using data from the entire scan.
- **Boxed:** With this checkbox selected, the parameter are calculated using data from within the box that is defined in the 3D Cursors parameters window of the Recipe Editor. (See *Figure 3.73*.)

Either one or both calculation options can be used. If both are used, two sets of calculations are performed and presented in the Analysis screen.

Each parameter is discussed below.

Figure 3.75 *3D General Parameters*



Adding 3D General Parameters to the Analysis

- In the **3D General Parameters** options box, click in the checkbox of any option (see *Figure 3.75*) to include them in the current recipe and display each data value in the **Analysis** screen. A check (✓) in the checkbox activates the parameter.
- Add all the **3D General Parameters** to the Analysis by clicking **Select All 3D** at the bottom of the list. This puts a check (✓) in the checkbox of all parameters. (See *Figure 3.75*)
- Remove all checked parameters from the **3D General Parameters** by clicking **Remove All 3D** at the bottom of the list. This removes all checks from any chosen parameters. (See *Figure 3.75*)

Table 3.25 *3D General Parameters*

Parameter	Description
Total Ind. Runout (TIR3D)	This is the 3D Total Indicator Runout. **TIR3D** is the difference between the highest and lowest points in the scan.
SlopeX	SlopeX refers to the slopes for lines in the plane: The SlopeX is the slope along the X-direction For the data set in any rectangular area (either a box or the entire area), a plane can be established using the *least squares* method.
SlopeY	SlopeY refers to the slopes for lines in the plane: The SlopeY is the slope along the Y-direction For the data set in any rectangular area (either a box or the entire area), a plane can be established using the *least squares* method.
Peak 3D (Sp)	Maximum Z value, measured relative to the leveled reference plane.
Valley 3D (Sv)	Minimum Z value, measured relative to the leveled reference plane.

Roughness and Waviness Parameters

Introduction

Roughness and Waviness are defined by the Long Wavelength Cutoff setting. In general, when a long wavelength cutoff is set, the wavelengths greater than the cutoff are defined as **Roughness** and those less than the cutoff are defined as **Waviness**. (See *Figure 3.76*.) The long wavelength cutoff setting is generally determined by the specific application for which it is to be used.

A filter is used to remove aspects of the data so other aspects can be more carefully analyzed. As an example, the roughness could be filtered out so the waviness could be better analyzed. (See *Figure 3.77*.)

For applications where the user is unsure of a specific long wavelength cutoff, use the general rule of 1/5 the scan length. This means that for a scan of 50 μm, the cutoff would be 10 μm.

Figure 3.76 *Waviness vs. Roughness*

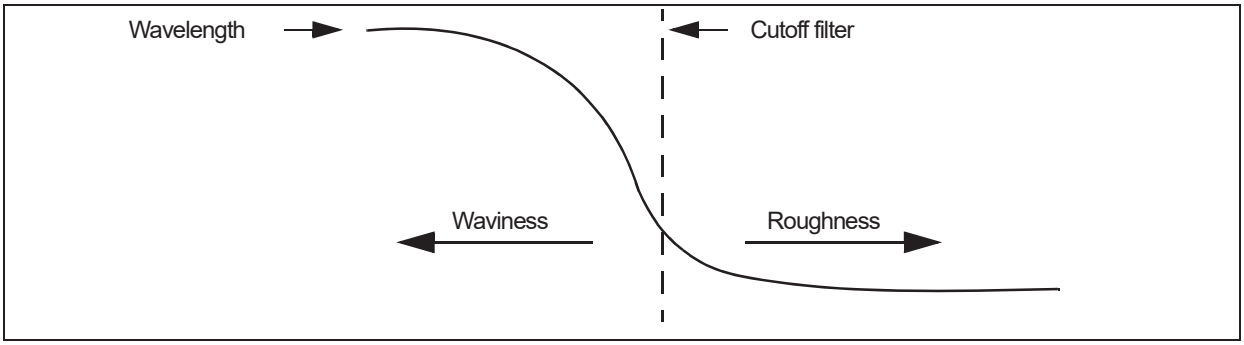


Figure 3.77 *Roughness/Waviness Filter Analysis*

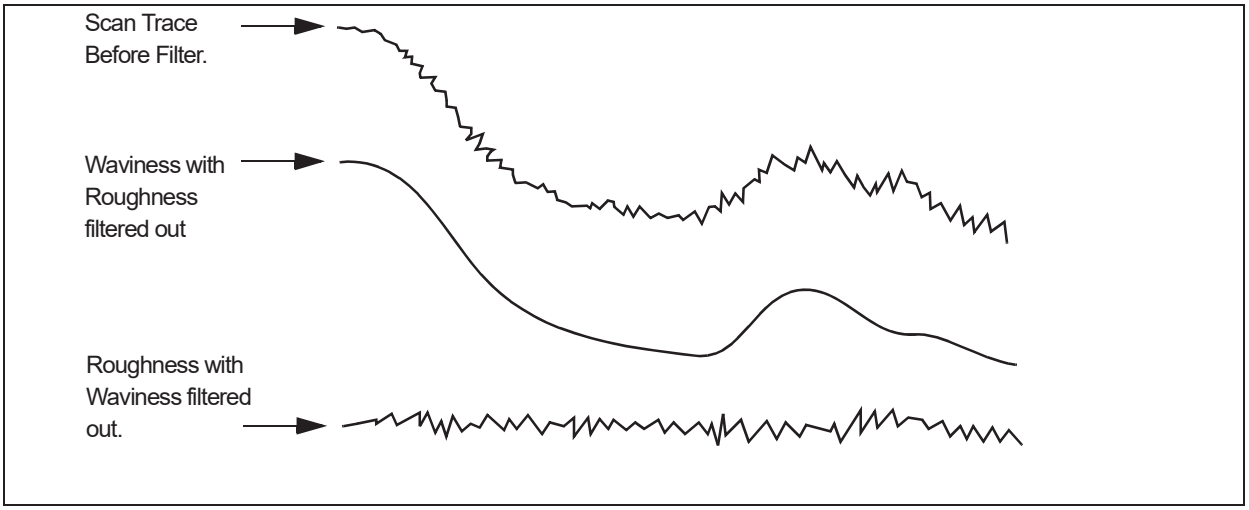
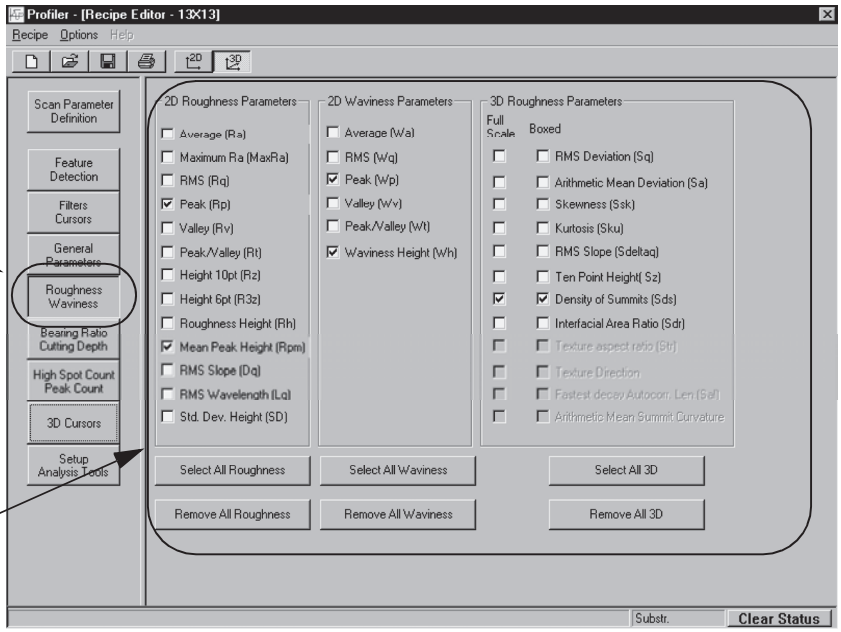


Figure 3.78 shows the Recipe Editor with the Roughness and Waviness parameters in the Information Display window.

Figure 3.78 *Recipe Editor Showing 2D and 3D Roughness/Waviness Parameters*

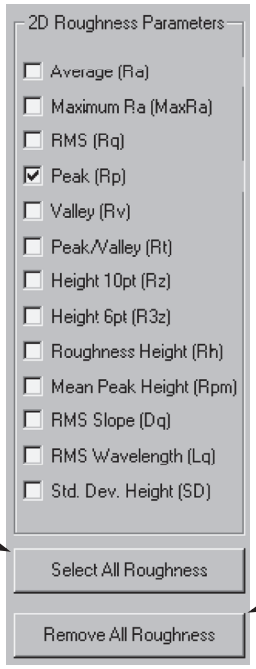
To display the Roughness and Waviness parameters in the Recipe Editor parameters window, click on the **Roughness/Waviness** button.

Roughness/Waviness parameters in the Information Display window.



2D Roughness Parameters

Figure 3.79 *2D Roughness Parameters Options*



To have the software calculate any of these parameters, click in the checkbox to put a check (✓) in it and activate it.

To select all the parameters for inclusion in the Analysis, click Select All Roughness.

When chosen, the data corresponding to each parameter is displayed in the **Analysis** screen.

These parameters can be applied to a scan after it is complete and before the data is saved. If the parameters are saved as part of the scan recipe, they are automatically used.

To remove all selected parameters from inclusion in the Analysis, click Remove All Roughness.

Each of the roughness parameters available in the **2D Roughness Parameters** option box are described in ***Table 3.26 on page 3-74***. (For more information Roughness, see the ***Introduction*** to *Roughness and Waviness Parameters on page 3-70*.)

Adding 2D Roughness Parameters to the Analysis

- In the **2D Roughness Parameters** options box, click in the checkbox of any option (see *Figure 3.79*) to include them in the current recipe and display each data value in the **Analysis** screen. A check (✓) in the checkbox activates the parameter.
- Add all the **2D Roughness Parameters** to the Analysis by clicking **Select All Roughness** at the bottom of the list. This puts a check (✓) in the checkbox of all parameters.
- Remove all checked parameters from the **2D Roughness Parameters** by clicking **Remove All Roughness** at the bottom of the list. This removes all checks from any chosen parameters.

2D Roughness Parameters Table

Table 3.26 *2D Roughness Parameters*

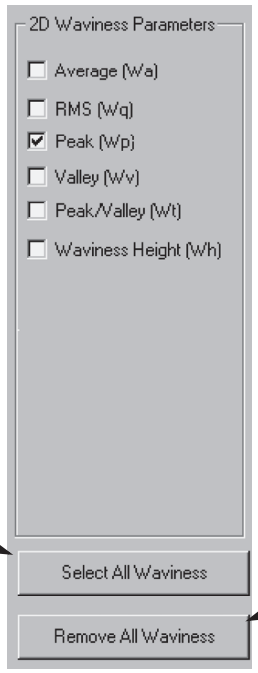
Parameter	Description
Average (R_a)	This is the arithmetic average deviation of the absolute values of the roughness profile from the mean line or centerline. Also known as *centerline average roughness*. The centerline divides profiles such that all areas above it are equal to all areas below it. (ANSI)
Maximum R_a (Max R_a)	The trace within the cursors is divided into nineteen overlapping sections. Each section is one-tenth of the sampling length. The R_a of each section is calculated, and the maximum is displayed. (ANSI)
RMS (R_q)	The Root-Mean-Square (RMS) or geometric average deviation of the roughness profile from the mean line measured in the sampling length. (ANSI)
Peak (R_p)	The distance between the mean line and the highest peak within the sampling length. (ANSI)
Valley (R_v)	The distance between the mean line and the lowest valley within the sampling length. (ANSI)
Peak/Valley (R_t)	The vertical distance between the highest peak and the lowest valley in the sampling length leveled on the mean line. (Also known as R_{max}, R_y, Maximum Peak-to-Valley Roughness.) (ANSI)
Height 10pt (R_z)	The average height difference between the five highest peaks and the five deepest valleys within the cursors measured from a line parallel to the mean line. (ANSI)
Height 6pt (R_{3z})	The average height difference between the three highest peaks and the three deepest valleys in the sampling length measured from a line parallel to the mean line and not crossing the profile. (ANSI)

Table 3.26 2D Roughness Parameters (Continued)

Parameter	Description
Roughness Height (R_h)	The difference in height in the roughness profile between the left and right cursor positions. Analogous to the Height data that always appears in the Summary box of the Analysis window. (ANSI)
Mean Peak Height (R_{pm})	The mean value of the local peak heights relative to the mean line of the roughness trace within the sampling length.
RMS Slope (D_q)	The root mean square (RMS) value of the roughness trace slope. The Delta cursors are not used.
RMS Wavelength (L_q)	2π times the ratio of the root mean square (RMS) deviation of the profile (R_q) to the root mean square slope of the profile (D_q). L_q is a measure of the spacing of local peaks and local valleys, taking into account their relative amplitudes and individual spatial frequencies. (ISO International Standards Organization)
Std. Dev. Height (SD)	The standard deviation of the local peak heights about the mean peak height relative to the mean line within the sampling length.

2D Waviness Parameters

Figure 3.80 2D Waviness Parameters



To have the software calculate any of these parameters, click in the checkbox to put a check (✓) in it and activate it.

When chosen, the data corresponding to each parameter is displayed in the **Analysis** screen.

These parameters can be applied to a scan after it is complete and before the data is saved. If the parameters are saved as part of the scan recipe, they are automatically used.

To select all the parameters for inclusion in the Analysis, click Select All Waviness.

To remove all selected parameters from inclusion in the Analysis, click Remove All Waviness.

Each of the waviness parameters available in the 2D Waviness Parameters option box

is described in ***Table 3.27 on page 3-76***. (For more information Waviness, see the ***Introduction*** to *Roughness and Waviness Parameters on page 3-70*.)

Adding 2D Waviness Parameters to the Analysis

- In the **2D Waviness Parameters** options box, click in the checkbox of any option (see *Figure 3.80*) to include them in the current recipe and display each data value in the **Analysis** screen. A check (✓) in the checkbox activates the parameter.
- Add all the **2D Waviness Parameters** to the Analysis by clicking **Select All Waviness** at the bottom of the list. This puts a check (✓) in the checkbox of all parameters.
- Remove all checked parameters from the **2D Waviness Parameters** by clicking **Remove All Waviness** at the bottom of the list. This removes all checks from any chosen parameters.

2D Waviness Parameters Description

Table 3.27 *2D Waviness Parameters*

Parameter	Description
Average (W_a)	This is the arithmetic average deviation of the absolute values of the waviness profile from the mean line or centerline also known as centerline average waviness). The centerline divides profiles such that all areas above it are equal to all areas below it. (ANSI)
RMS (W_q)	The Root-Mean-Square (RMS) or geometric average deviation of the waviness profile from the mean line measured in the sampling length. (ANSI)
Peak (W_p)	The distance between the mean line and the highest peak within the sampling length. (ANSI)
Valley (W_v)	The distance between the mean line and the lowest valley within the sampling length. (ANSI)
Peak/Valley (W_t)	The vertical distance between the highest peak and the lowest valley in the sampling length leveled on the mean line. Also known as W_{max}, W_y, Maximum Peak-To-Valley Waviness. (ANSI)
Waviness Height (W_h)	The difference in height in the waviness profile between the left and right cursor positions. Analogous to the Height data that always appears in the Summary box of the Analysis window. (ANSI)

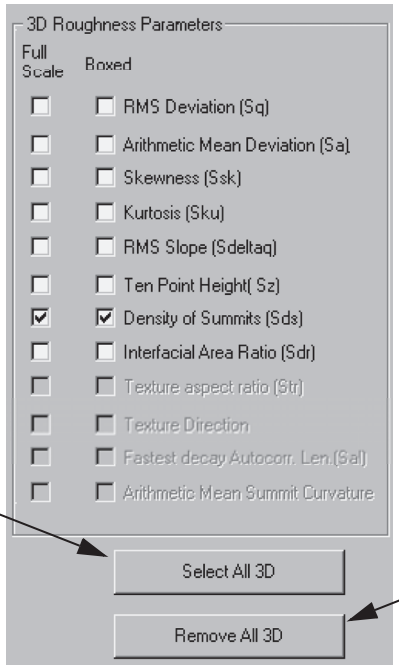
3D Roughness Parameters

Each of the roughness parameters available in the 3D Roughness Parameters option box is described in *Table 3.28 on page 3-78*. (For more information Roughness, see the *Introduction* to *Roughness and Waviness Parameters* on page 3-70.)

Add 3D Roughness Parameters to Analysis

- In the **3D Roughness Parameters** options box, click in the checkbox of any option (see *Figure 3.81*) to include them in the current recipe and display each data value in the **Analysis** screen. A check (✓) in the checkbox activates the parameter.
- Add all the **3D Roughness Parameters** to the Analysis by clicking **Select All 3D** at the bottom of the list. This puts a check (✓) in the checkbox of all parameters.
- Remove all checked parameters from the **3D Roughness Parameters** by clicking **Remove All 3D** at the bottom of the list. This removes all checks from any chosen parameters.

Figure 3.81 *3D Roughness Parameters*



Either or both of the options for each parameter can be chosen. To have the software calculate any of these parameters, click in the checkbox to put a check (✓) in it and activate it.

To select all the parameters for inclusion in the Analysis, click Select All 3D.

When chosen, the data corresponding to each parameter is displayed in the **Analysis** screen.

Although these parameters can be applied to a scan after it is complete and before the data is saved, if the parameters are chosen as part of the recipe being used to perform the scan, they are automatically included and can be accessed any time in the future.

To remove all selected parameters from inclusion in the Analysis, click Remove All 3D.

Each parameter option can be calculated in two different ways:

- **Full Scale:** With this checkbox selected, the parameter are calculated using data from the entire scan.
- **Boxed:** With this checkbox selected, the parameter are calculated using data from within the box that is defined in the 3D Cursors parameters window in the Recipe Editor. (See *Figure 3.73*.)

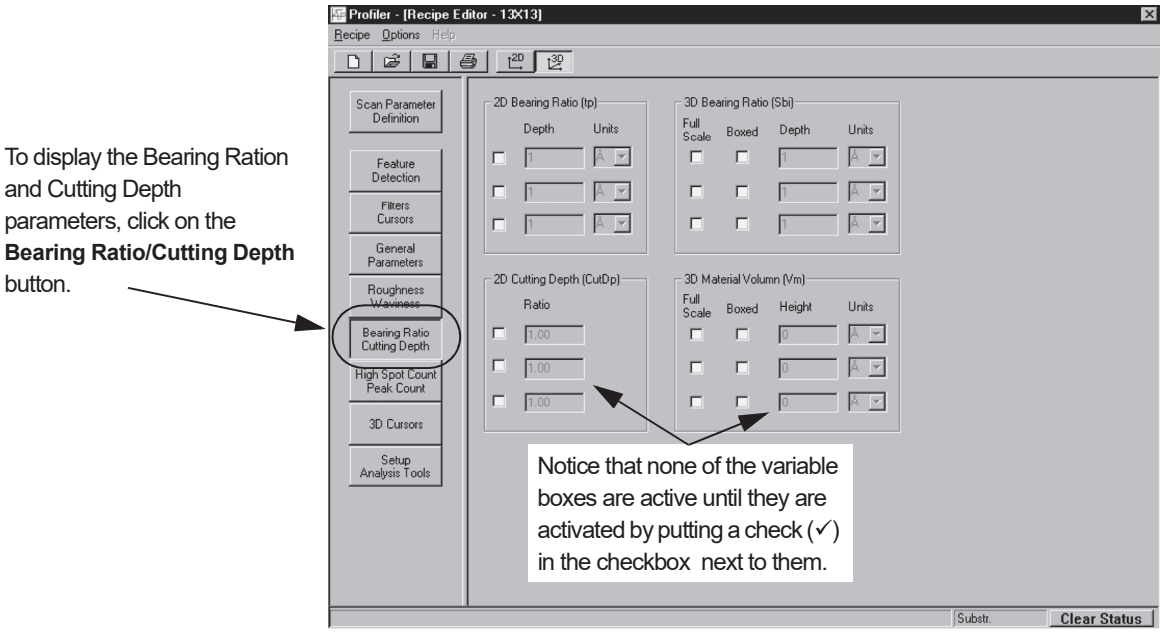
Table 3.28 *3D Roughness Parameters*

Parameter	Description
RMS Deviation (S_q)	Root-Mean-Square Deviation of the Surface. The root-mean-square value of the surface departures within the sampling area.
Arithmetic Mean Deviation (S_a)	Arithmetic Mean Deviation of the Surface. The arithmetic mean of the absolute values of the surface departures above and below the mean plane within the sampling area.
Skewness (S_{sk})	The measure of asymmetry of surface deviations about the mean plane. It effectively describes the shape of the surface height distribution.
Kurtosis (S_{ku})	A measure of the peakedness or sharpness of the surface height distribution. It characterizes the spread of the height distribution.
RMS Slope ($S_{delta\ q}$)	The root-mean-square value of the surface slope within the sampling area. RMS slope is sensitive to sampling rate.
Ten Point Height (S_z)	The average value of the absolute heights of the five highest peaks and the depths of the five deepest pits or valleys within the sampling area.
Density of Summit (S_{ds})	The number of summits of a unit sampling area.
Interfacial Area Ratio (S_{dr})	The ratio of the increment of the interfacial area of a surface over the sampling area. The Interfacial Area Ratio reflects the hybrid property of surface.

Bearing Ratio and Cutting Depth

Access the Bearing Ratio and Cutting Depth Information Display window by clicking the Bearing Ration/Cutting Depth button in the Recipe Editor. (See *Figure 3.82*.)

Figure 3.82 *Bearing Ration and Cutting Depth Parameters*

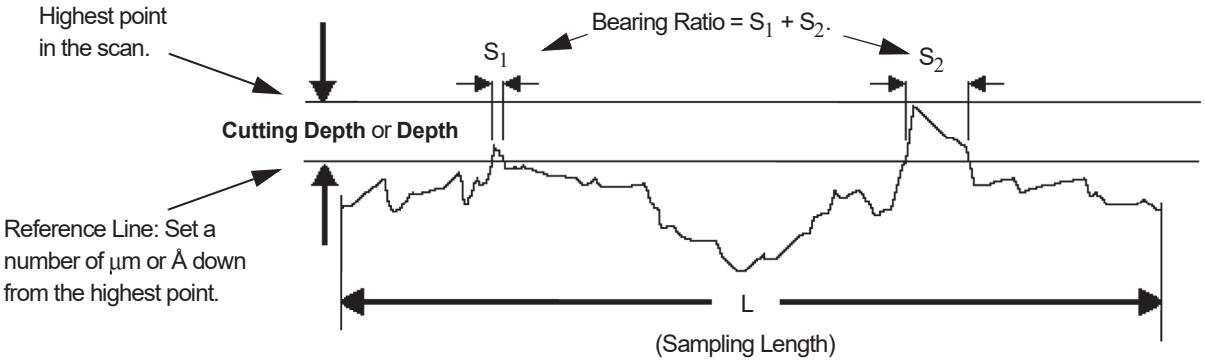


Bearing Ratio (t_p)

Bearing Ratio is also know as **Bearing Length Ratio** (t_p). ANSI defines it as:

> **Bearing Length Ratio (t_p) and Others**. A reference line is drawn parallel to the mean line and at a preselected or predetermined distance from it to intersect the profile in one or more subtended lengths. The bearing length ratio is the ratio of the sum of these subtended lengths to the length of the mean line.

Figure 3.83 *Bearing Ratio*



The **Bearing Ratio** is determined according to the following formula:

$$t_p = \frac{S1 + S2}{L}$$

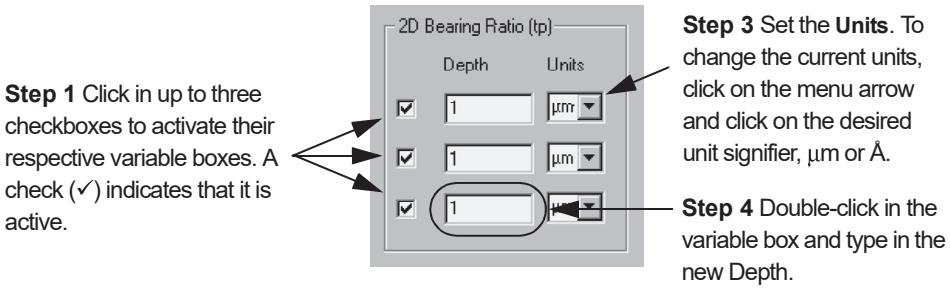
The **bearing length** is the sum of the subtended lengths (S1 and S2 in *Figure 3.83*). The **bearing ratio** is the ratio of the bearing length to the sampling length (L in *Figure 3.83*) as shown in the above formula.

Setting the 2D Bearing Ratio

Use the following procedure to set the 2D Bearing Ratio variables.

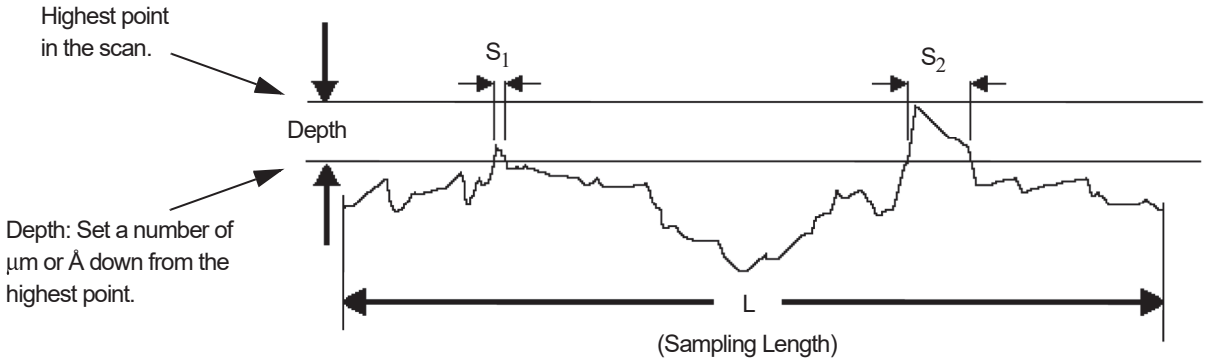
1. The option exists to create three 2D bearing ratio parameters. Click in up to three empty checkboxes to put a check (✓) in them and activate their variable boxes. (See *Figure 3.84*.)

Figure 3.84 *2D Bearing Ratio*



2. The depth is set down from the highest peak in the scan. It can be set in either microns (µm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click on the menu arrow under units to display its menu.
3. Click on the desired unit signifier, µ**m** or **Å**.
4. **Depth** is the distance down from the top of the highest point in the scan. To set or change the **Depth**, double-click on the current **Depth** variable and type in the new depth. (See *Figure 3.85*.)

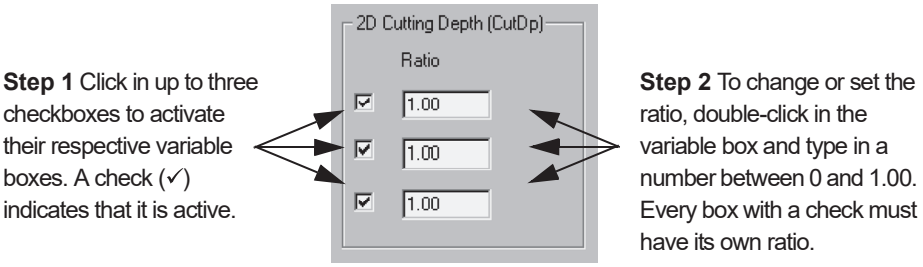
Figure 3.85 *Depth*



2D Cutting Depth (CutDp)

Cutting Depth is related to Bearing Ratio in that Bearing Ratio uses an operator set depth from the top peak in the scan, adding up the points between the top peak and the set depth, while **Cutting Depth** uses an operator set *ratio of data points* in the scan that are below the highest peak in the scan, causing the system to determine the depth. (See the definition of **Bearing Length Ratio** in *Bearing Ratio (tp)* on page 3-79.)

Figure 3.86 *2D Cutting Depth (CutDp)*



Use the following procedure to set the 2D Cutting Depth variables.

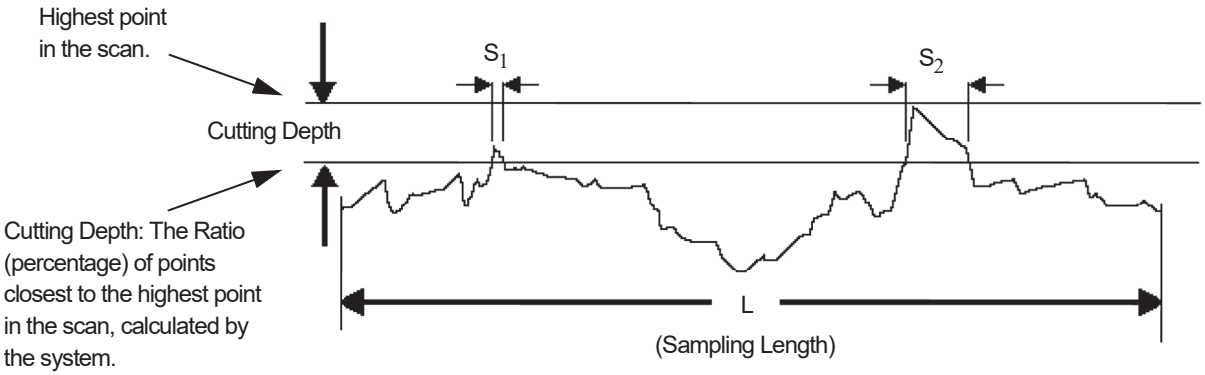
1. The option exists to create three 2D cutting depth parameters. Click in up to three empty checkboxes to put a check (✓) in them and activate their variable boxes. (See *Figure 3.86*.)
2. The Cutting Depth is a ratio of points below the highest peak in the scan. The operator chooses the ratio and the software automatically takes the that ratio of data points in the scan that are the closest to the highest peak and calculates the Cutting Depth (CutDp) variable, displaying the results in the Analysis screen.

   EXAMPLE:

   If the user want to calculate a set of parameters comparing 20%, 30%, and 40% cutting depth, all three check boxes are checked and the respective variable boxes have: **0.20**, **0.30**, and **0.40** in them.

   To set or change one or more of the Cutting Depth variables, double-click on the number in the variable field so that it highlights, and type in the new ratio. (See *Figure 3.86*.)

Figure 3.87 *Cutting Depth*



3D Bearing Ratio (Sbi)

The 3D Bearing Ratio is a 3D version of the 2D Bearing Ratio in that it uses a distance down from the highest point in the scan to compute a bearing ratio with respect to a plane instead of area with respect to a single line trace.

In addition, two options are available for each of three parameter settings for calculating the 3D Bearing Ratio. The scope of the calculation is set by clicking in ***one or both*** of the range boxes: **Full Scale** and **Boxed**. The depth can then be set.

Full Scale - This option performs a calculation of the 3D Bearing Ratio over the entire scan.

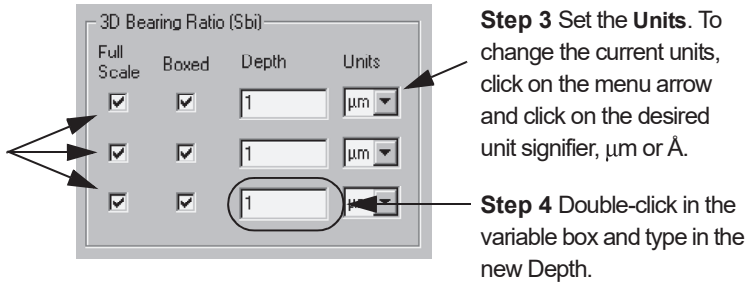
Boxed - This option performs a calculation of the 3D Bearing Ratio over the portion of the scan within the box that is defined in the 3D cursors parameters window. (See *Figure 3.88*.)

Use the following procedure to set the 3D Bearing Ratio variables.

1. To chose the scope of the 3D Bearing Ratio calculation, click in the empty checkbox to activate the variable field and place it in the recipe. **Either or both** options can be chosen.

   Choose up to three sets of calculations with different depths. If all boxes are checked, two calculations are performed for each of the three variable depths.

Figure 3.88 *3D Bearing Ratio (Sbi)*



2. The depth is set down from the highest peak in the scan. It can be set in either microns (µm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click on the menu arrow under units to display its menu.
3. Click on the desired unit signifier, µ**m** or **Å**.
4. The **Depth** is the distance down from the top of the highest point in the scan. To set or change the **Depth**, double-click on the current **Depth** variable and type in the new depth.

3D Material Volume (Vm)

The 3D Material Volume is a 3D version of the 2D Cutting Depth Ratio. It is set by using a ratio (percentage) of the overall data points below the highest peak in the scan to compute a material volume (Vm) with respect to a plane instead of area with respect to a single line trace.

In addition, two options are available for each of three parameter settings for calculating the 3D Material Volume. The scope of the calculation is set by clicking in ***one or both*** of the range boxes: **Full Scale** and **Boxed**. The depth can then be set.

Full Scale - This option performs a calculation of the 3D Bearing Ratio over the entire scan.

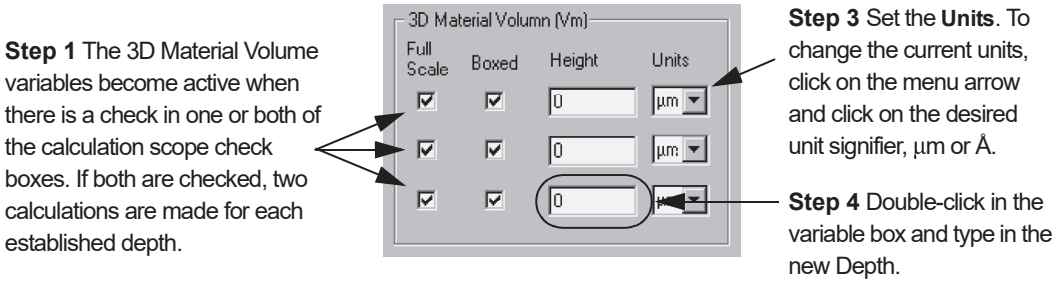
Boxed - This option performs a calculation of the 3D Bearing Ratio over the portion of the scan within the box that is defined in the 3D cursors parameters window. (See *Figure 3.89*)

Use the following procedure to set the 3D Material Volume variables.

1. To choose the scope of the 3D Material Volume calculation, click in the empty checkbox to activate the variable field and place it in the recipe. **Either or both** options can be chosen.

   Choose up to three sets of calculations with different depths. If all boxes are checked, two calculations are performed for each of the three variable depths.

Figure 3.89 *3D Material Volume*



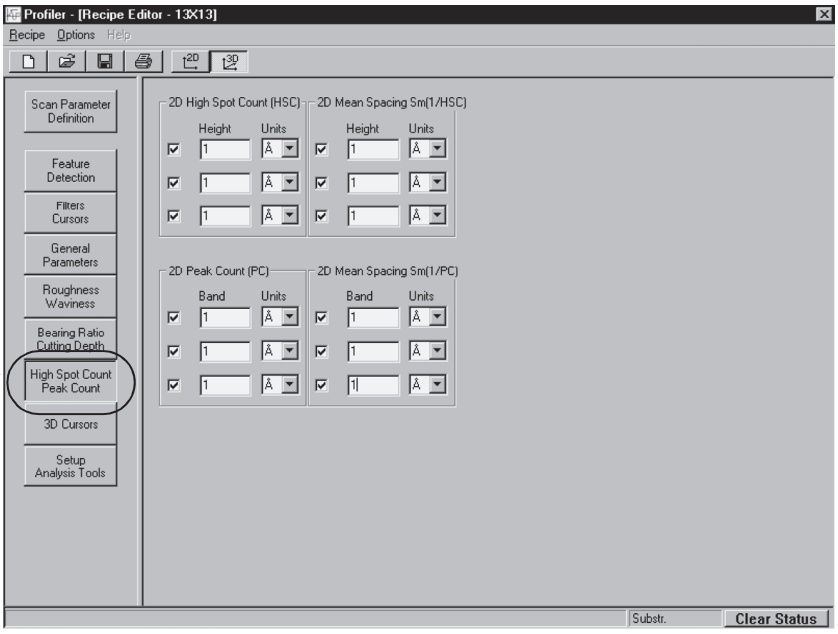
2. The depth is set down from the highest peak in the scan. It can be set in either microns (µm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click on the menu arrow under units to display its menu.
3. Click on the desired unit signifier, **µm** or **Å**.
4. The **Depth** is the distance down from the top of the highest point in the scan. To set or change the **Depth**, double-click on the current **Depth** variable and type in the new depth.

High Spot Count and Peak Count

Access the High Spot Count and Peak Count Display Window by clicking the **High Spot Count/Peak Count** button in the Recipe Editor. (See *Figure 3.90*.)

Figure 3.90 *Bearing Ratio and Cutting Depth Parameters*

To display the High Spot Count and Peak Count parameters, click on the **High Spot Count/Peak Count** button.



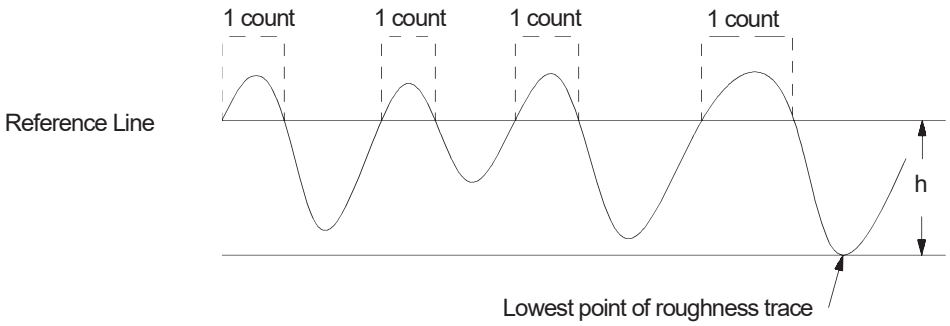
High Spot Count (HSC)

High Spot Count is the number of profile peaks per unit of length projecting through a reference line parallel to and at a given height above, a line drawn parallel to the mean line through the lowest point of the roughness trace. (See *Figure 3.91*).

The mean line is the line at the mean height of all data. Another line is drawn through the lowest point in the trace, parallel to the mean line. The reference line is at a user specified height above the lowest point line.

Projecting through means that the profile curve first climbs above the reference line and then falls below it. Thus, if the profile rises above the reference line, descends without falling below it, then rises again, multiple peaks are not identified.

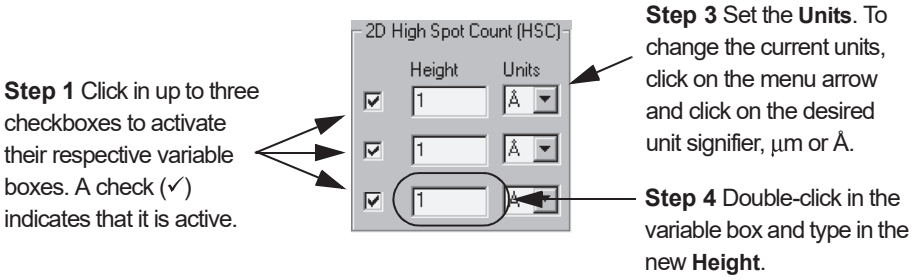
Figure 3.91 *High Spot Count*



Use the following procedure to set the 2D High Spot Count variables.

1. The option exists to create three 2D High Spot Count parameters. Click in up to three empty checkboxes to put a check (✓) in them and activate their variable boxes. (See *Figure 3.92*.)

Figure 3.92 *2D High Spot Count (HSC)*



2. The height can be set in either microns (μm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click on the menu arrow under units to display its menu.
3. Click on the desired unit signifier, **μm** or **Å**.
4. The **Height** is the distance **up** from the lowest point of the roughness trace.

   To set or change the Height, double-click on the current **Height** variable and type in the new height. (See *Figure 3.92*.)

2D Mean Spacing Sm (1/HSC)

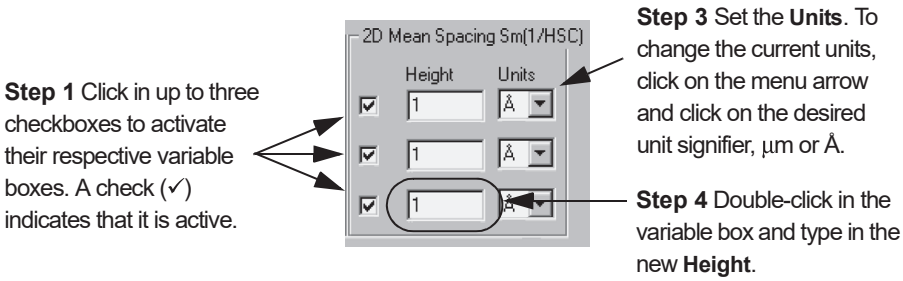
Mean Peak spacing is the mean value of the local peak spacing of the profile within the sampling length. The peaks for High Spot Count are defined by the Height parameter from the High Spot Count window. ***Spacing*** is the inverse of the count.

It is important to note that the **2D High Spot Count (HSC)** and the **2D Mean Spacing Sm (1/HSC)** are related. If running a scan in which these values are to be compared, the ***height*** **of both must be identical** for the data to have direct correlation.

Use the following procedure to set the 2D Mean Spacing Sm variables.

1. The option exists to create three 2D Mean Spacing Sm parameters. Click in up to three empty checkboxes to put a check (✓) in them and activate their variable boxes. (See *Figure 3.93*.)

Figure 3.93 *2D Mean Spacing Sm (1/HSC)*



2. The height can be set in either microns (µm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click on the menu arrow under units to display its menu.
3. Click on the desired unit signifier, µ**m** or **Å**.
4. The **Height** is the distance **up** from the lowest point of the roughness trace. In most scans, this value is compared to High Spot Count (HSC) so this height must be identical to the **Height** in **High Spot Count (HSC)**.

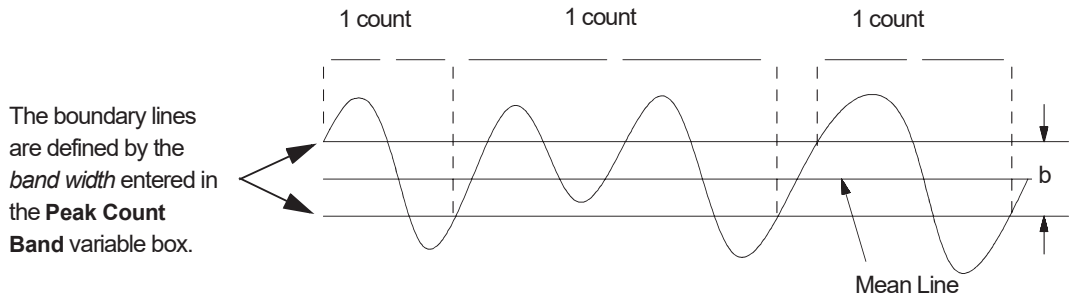
   To set or change the Height, double-click on the current **Height** variable and type in the new height. (See *Figure 3.93*.)

2D Peak Count (PC)

Peak Count is the number of peak and valley pairs per unit length projecting through a band of width **b** centered about the mean line. (See *Figure 3.94*.)

The Mean line is the line at the mean height of all data. The band is the area bounded by two lines running parallel to the mean line, at an equal distance from the mean line.

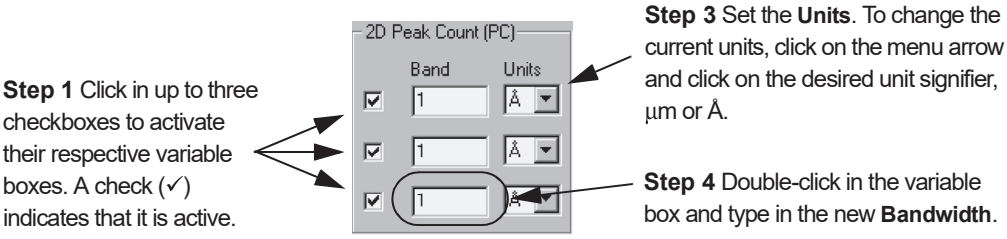
Figure 3.94 *Peak Count*



Use the following procedure to set the 2D Peak Count variables.

1. The option exists to create three 2D Peak Count bandwidth settings. Click in up to three empty checkboxes to put a check (✓) in them and activate their variable boxes. (See *Figure 3.95*.)

Figure 3.95 *2D Peak Count (PC)*



2. The bandwidth can be set in either microns (µm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click on the menu arrow under units to display its menu.
3. Click on the desired unit signifier, **µm** or **Å**.
4. The **Band** is the bandwidth surrounding the mean line. (See *Figure 3.94*.)

   To set or change the Band, double-click on the current **Band** variable and type in the new bandwidth. (See *Figure 3.95*.)

2D Mean Spacing Sm (1/PC)

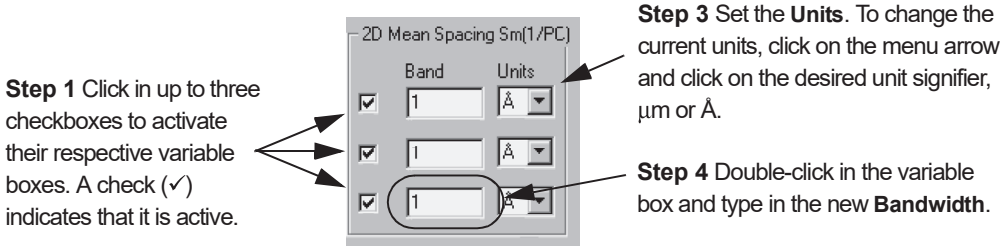
Mean Peak spacing is the mean value of the local peak spacing of the profile within the sampling length. The peaks for Peak Count are defined by the **Band** (bandwidth) parameter from the Peak Count (PC) window. ***Spacing*** is the inverse of the count. (See *Figure 3.94*.)

It is important to note that the **2D Peak Count (PC)** and the **2D Mean Spacing Sm (1/PC)** are related. If running a scan in which these values are to be compared, the ***bandwidth* of both must be identical** for the data to have direct correlation.

Use the following procedure to set the 2D Mean Spacing Sm

1. The option exists to create three 2D High Spot Count parameters. Click in up to three empty checkboxes to put a check (✓) in them and activate their variable boxes. (See *Figure 3.96*.)

Figure 3.96 *2D Mean Spacing Sm (1/PC)*



2. The bandwidth can be set in either microns (μm) or angstroms (Å). Determine which units are going to be used and, if a change is necessary, click on the menu arrow under units to display its menu.
3. Click on the desired unit signifier, **μm** or **Å**.
4. The **Band** is the bandwidth bordered equidistant above and below the mean line of the scan. In most scans, this value is compared to **Peak Count (PC)** so this **Band** (bandwidth) must be identical to the **Band** in **Peak Count (PC)**.

   To set or change the Band, double-click on the current **Band** variable and type in the new bandwidth. (See *Figure 3.96*.)

3D Cursors Parameters

Introduction

The 3D Cursors screen is designed to allow the user to view the cursor coordinates, and manipulate the cursor position and boundaries by coordinate. (See *Figure 3.97*.) Those who frequently use 3D cursors have found it more accurate to drag and drop the cursor boundaries rather than attempt to pin point them using the 3D Cursors window.

If necessary, it is possible to drag the cursor boundaries and then go into the 3D Cursors screen and fine tune the boundary settings. Fine tuning is, however, seldom done. In general, the 3D Cursors screen is only used as a reference screen.

X Start Level

This option is used to level the 3D scan with respect to the X starting position of the scan. It assumes that the entire X=0 length of the scan is on the same plane, having no holes or steps. If this box is checked, the other options are not used in the leveling process. This option only levels in one direction, with respect to the X=0 plane.

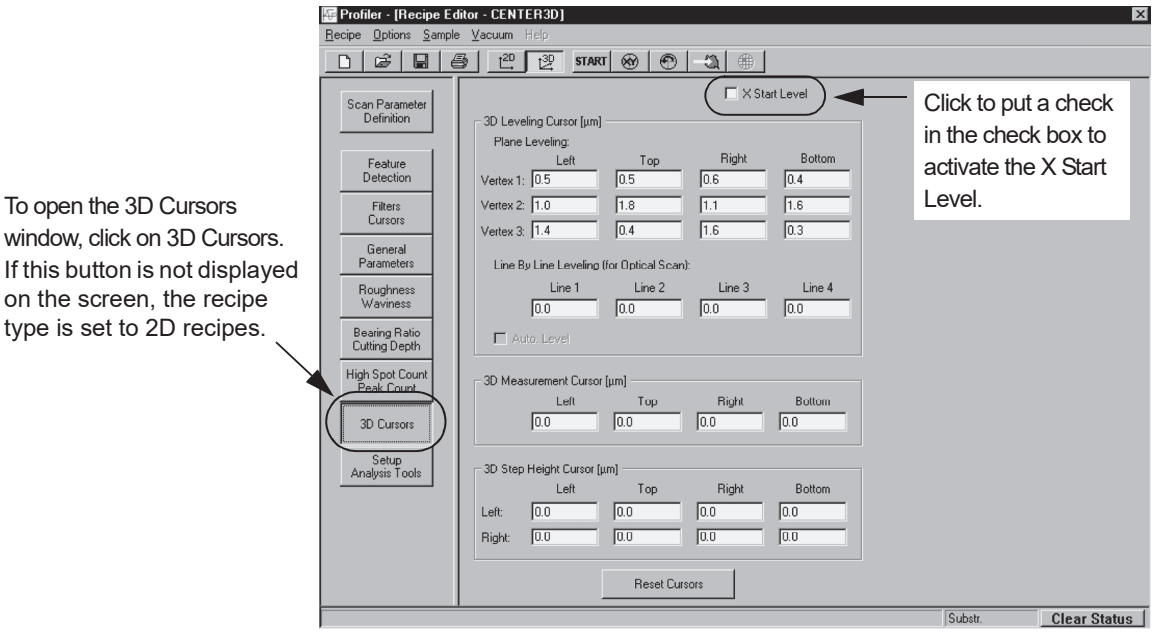
Initializing X Start Level

To activate the **X Start Level** option, click in the empty checkbox next to X Start Level. (See *Figure 3.97*.)

Leveling Criteria

The 3D scan progresses with each initial trace data point being used for the scan leveling in the Y direction (using the X=0 point of each scan trace).

Figure 3.97 *Recipe Editor - Choosing 3D Cursors*



3D Leveling Cursor (µm)

The 3D Leveling Cursor field presents the option to define the three boxes that are used in the three-point leveling procedure. (See *Figure 3.98*.) This option is used by the system for leveling if neither the **X Start Level** nor the **Auto Level** checkboxes are checked. Each horizontal row of coordinates, called a vertex (after the old single point procedure that was used in the past), actually defines a box surrounding a set of data points. To be accurately used in the data leveling procedure, each box must contain only data points on the same plane. All three boxes must be located on the same plane to accurately level the data.

Setting the Cursors: Click-and-Drag

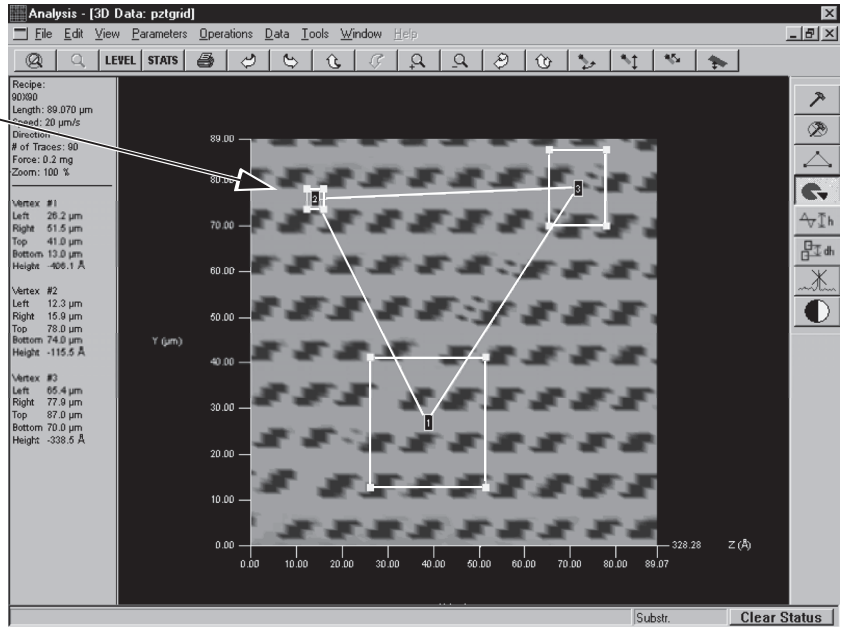
Click-and-Drag Cursor Positioning

If the tool bar's **Activate Leveling Tool** button icon was used to place the leveling cursors on the scan image, then it is possible to click-and-drag the boxes to the best positions for leveling purposes. After being positioned, they can be sized to include only the proper data. It is essential that each box contain data from only one plane, no steps or holes. All three boxes must contain data from the same plane. (See *Figure 3.98*.)

Figure 3.98 *Three Point Leveling Showing Leveling Boxes*

Notice that leveling on one plane is difficult for the illustrated sample. Only one box contains data residing on only one plane.

The other two boxes would require adjustment in size so only the level represented by the lighter color is included in their boundaries.



After the boxes are positioned properly, with the content in all three boxes being on the same plane, leveling can take place. When the leveling is complete and saved, the coordinates of each one are recorded in the **Plane Leveling** boxes. (See *Figure 3.98*.) Each set of coordinates correspond to a box and are labeled with Box 1 being represented by Vertex 1, and so on with Boxes 2 and 3. (For more information on 3D leveling, see *Activate Leveling Tool on page 9-15* in the 3D Analysis chapter.)

The coordinates are as follows: (See *Figure 3.99*.)

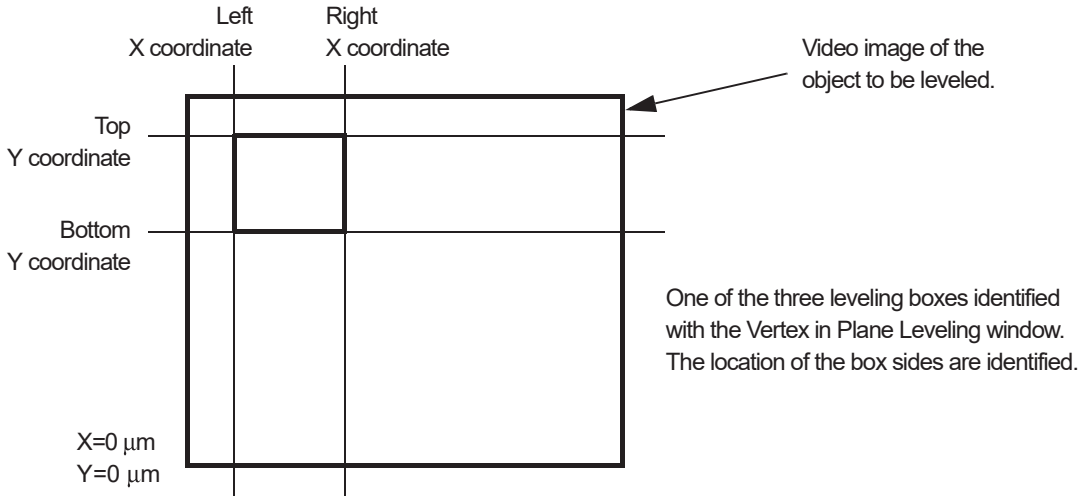
Left – This corresponds to the left side of the cursor box and is the X coordinate of that location. (See *Figure 3.98*.)

Right – This corresponds to the right side of the cursor box and is the X coordinate of that location. (See *Figure 3.98*.)

Top – This corresponds to the top of the cursor box and is the Y coordinate of that location. (See *Figure 3.98*.)

Bottom – This corresponds to the bottom of the cursor box and is the Y coordinate of that location. (See *Figure 3.98*.)

Figure 3.99 *Vertex Identification*



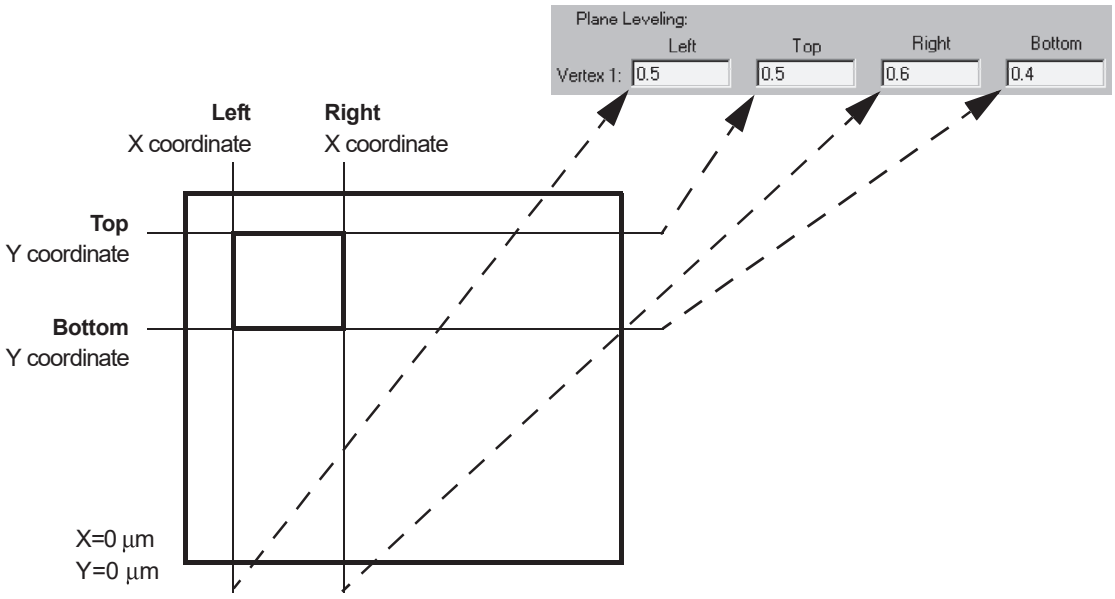
Setting the Cursors: Enter Coordinates in 3D Cursor Window

Cursor Positioning by Manually Setting the Coordinates

It is possible, for certain types of 3D production scans, to preset the 3D cursors for repetitive scans by entering the coordinates in the respective boxes. This works better with scans where most of the scan surface is on the same plane and the features being scanned are located far enough away from other features to allow preset leveling. Use the X and Y screen coordinates, with X=0, Y=0 being the bottom left corner of the scan area. (See *Figure 3.99*.) Enter the number for each coordinate in the corresponding Vertex variable box. (See *Figure 3.100*.)

NOTE: It is difficult to place these exactly by simply entering a number. It might require entering the number and observing the results several times to correctly position the cursor.

Figure 3.100 *Matching Leveling Box and Cursor Locations*

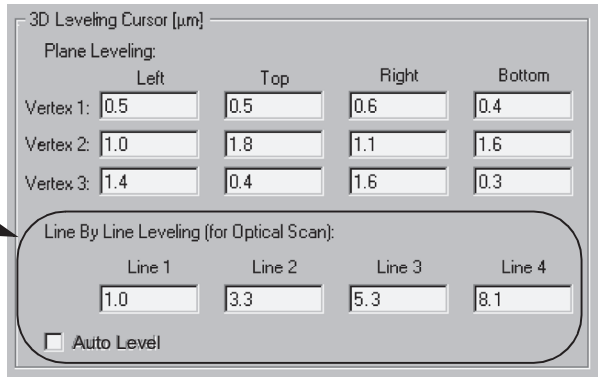


Line by Line Leveling

Line by line leveling was a feature for optical scans only. It is not available in the current systems.

Figure 3.101 *3D Leveling Cursor*

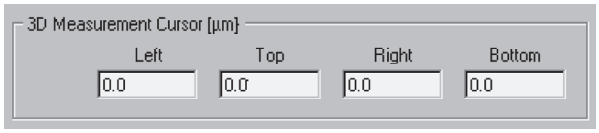
The Line By Line Leveling is not available in the current systems.



3D Measurement Cursor

The 3D measurement cursor is used to isolate an area of the scan, from which the measurements designated in the recipe for inclusion in the Analysis data (such as some of the parameters in General Parameters on page 65 and Roughness and Waviness Parameters on page 70), can be reported. If no numbers are entered in the 3D Measurement Cursor variable boxes to define the measurement area, the data is compiled for the entire scan area.

Figure 3.102 *3D Measurement Cursor Box*



Setting the Cursors: Click and Drag

Cursor Positioning Using Click-and-Drag

The **3D Measurement Cursor** box is associated with the **Activate Height Tool** button  in the Analysis screen tool bar. In the Analysis screen, if the Activate Height Tool button is clicked on, a box appears that can be resized and moved using the click-and-drag method. As the box is drug around the scan image, the height of all data points in the box is averaged with respect to sample plane and reported under **Height** in the analysis statistics at the left side of the screen.

Set the Box Position in the 3D Measurement Cursor Variable Boxes

After the box is sized and positioned, its position can be entered in the 3D Measurement Cursor variable boxes.

1. Click on the **CALC** icon in the toolbar or click on **Operations** in the menu bar
2. Choose **Recalc**, to recalculate the parameters and place the cursor locations in the 3D Measurement Cursor variable boxes.

Setting the Cursors: Manually Entering Coordinates

Manually setting the cursors is accomplished by entering the coordinate position of the intended measurement box (Active Height Tool) directly into the **3D Measurement Cursors** variable boxes. The coordinates work as follows:

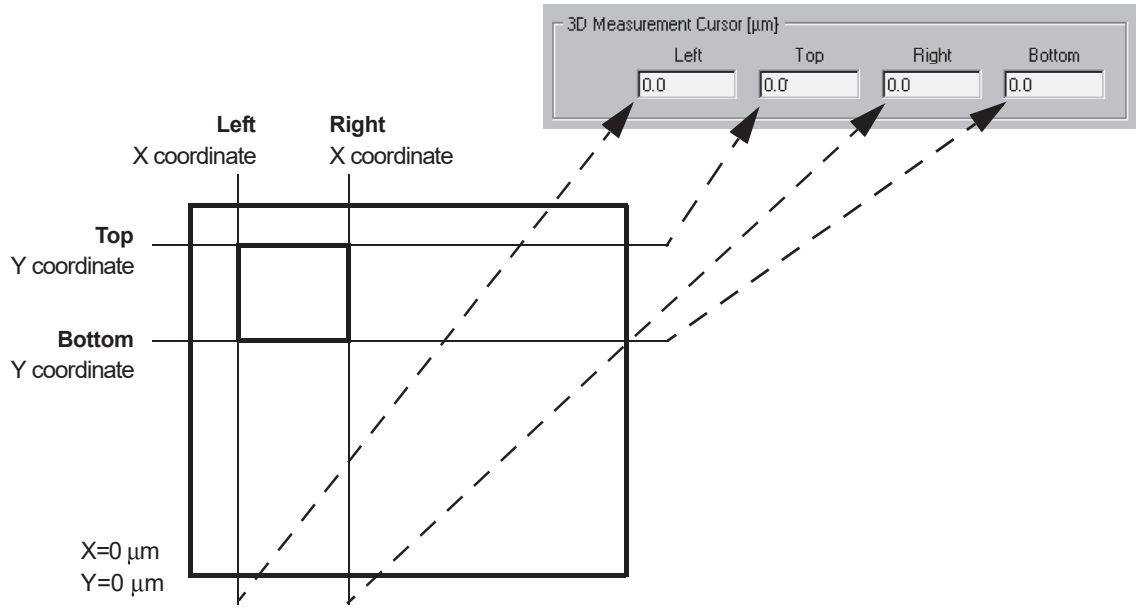
Left – This corresponds to the left side of the cursor box and is the X coordinate of that location. (See *Figure 3.103*.)

Right – This corresponds to the right side of the cursor box and is the X coordinate of that location. (See *Figure 3.103*.)

Top – This corresponds to the top of the cursor box and is the Y coordinate of that location. (See *Figure 3.103*.)

Bottom – This corresponds to the bottom of the cursor box and is the Y coordinate of that location. (See *Figure 3.103*.)

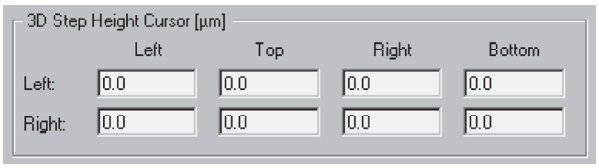
Figure 3.103 *Matching Measurement Cursor Position to Measurement Box*



3D Step Height Cursors

The 3D Step Height Cursors are two variable boxes that are designed to capture data on two planes and calculate the average difference in the height between them. For accurate results, all of the data in a cursor box should be on the same plane. In this way, the difference between the data in the two boxes is the average difference between the height of the two planes being measured.

Figure 3.104 *3D Step Height Cursor Parameters*



Setting the Cursors: Click and Drag

Cursor Positioning Using Click-and-Drag

The **3D Step Height Cursor** boxes are associated with the **Activate Step Height Tool** button  in the Analysis screen tool bar. In the Analysis screen, if the Activate Step Height Tool button is clicked on, two boxes appear that can be resized and moved using the click-and-drag method. As the boxes are drug around the scan image, the height of all data points in the box is averaged with respect to sample plane and reported under one of the height measurements (depending on which cursor box is being moved) in the analysis statistics at the left side of the screen.

1. If the view of the sample surface is not from the top, click **View** in the menu bar to display it menu.
2. Choose **Top** from the View menu.
3. To determine the step height in the Analysis screen, the system subtracts the Z value of **Box 1** from the Z value of **Box 2**. The **Left** box, in the **3D Cursors** window, correlates to **Box 1** in the Analysis screen. This box should be placed on the lowest plane. Click in the center of **Box 1** and drag it to the base plane.

NOTE: If Box 1 is placed on the step plane instead of the base plane, the height reading is given as a negative number.

4. Resize the box to the proper dimensions to avoid artifacts and keep it separate from other planes.
5. Click in the center of Box 2 and drag it to the step plane.
6. Resize the box to the proper dimensions to avoid artifacts and keep it separate from other planes (like step edges or slopes).

Set the Box Position in the 3D Step Height Cursors Variable Boxes

After the box is sized and positioned, its position can be entered in the 3D Measurement Cursor variable boxes (see *Figure 3.104*) using the following procedure.

1. Click on the **CALC** icon in the tool bar, or to use the menu option on **Operations** in the menu bar to display its menu.
2. From the Operations menu, choose **Recalc**.

   Both methods recalculate the parameters and place the cursor locations in the 3D Measurement Cursor variable boxes.

Setup Analysis Tools

This tool has two purposes that are used in the Analysis of the gathered data.

- First, the leveling of the data is accomplished based on a choice of data to be used as a leveling basis.
- Second, the data is compiled as a histogram for comparison of feature depth in the scan.

The parameters available in this window work on already accumulated data. Therefore, the parameters can be adjusted and recalculated over and over again on the same data to help analyze the scan results.

Both the leveling and the depth analysis histogram are discussed in this section.

Leveling Reference

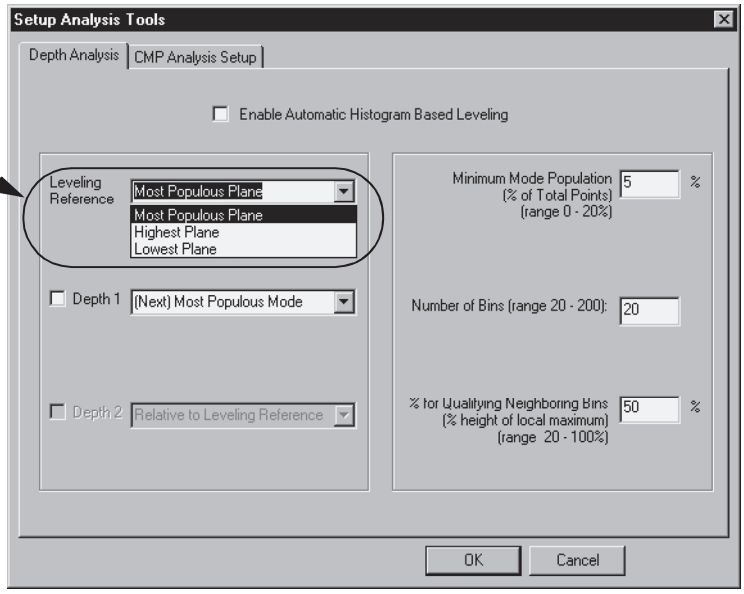
The system offers three data planes to choose from for leveling the scan data. (See *Figure 3.105*.) The three options are:

- Most Populous Plane
- Highest Plane
- Lowest Plane

The leveling takes place based upon the data points identified in one of the three data distribution planes identified above. The planes are associated with modes that are defined as a bin or group of bins that hold a significant number of data points. The total Z-axis distance of the scanned object is divided up into equal Z-axis portions called bins.

Figure 3.105 *Setup Analysis Tools – Leveling Reference*

The Leveling Reference options are displayed by clicking on the menu arrow in the **Leveling Reference** field.



The data bins form a histogram generated by the scan data. The contents of the bins are set using the parameters displayed directly below the Leveling Reference variable box in the **Setup Analysis Tools** dialog box. The parameters are:

- Number of Bins
- % for qualifying neighboring bins

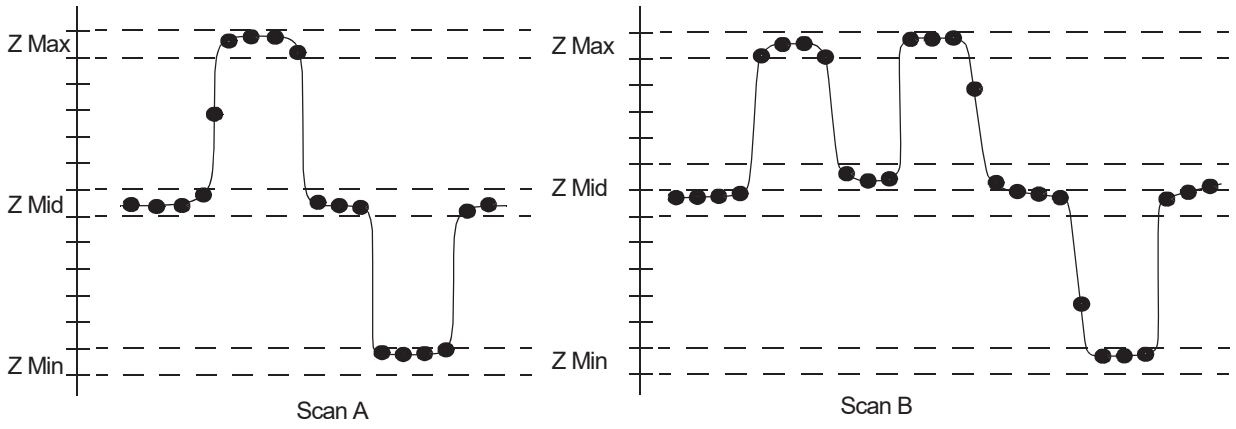
Number of Bins

Bins are actually ranges in the Z scan height. The total Z scan height is divided by the number of **Bins** chosen. Each bin presents the number of data points collected in its range, as compiled from data collected across the entire scan length.

Percentage (%) for Qualifying Neighboring Bins

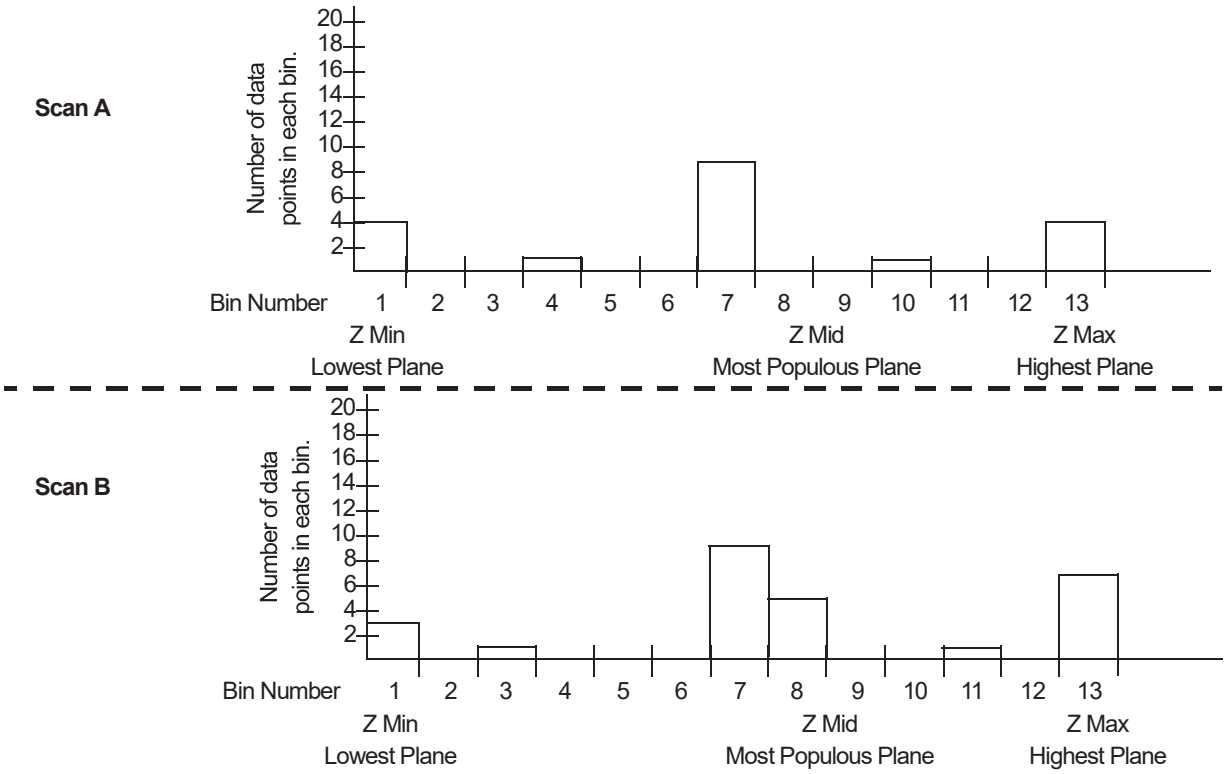
While it is possible to set up the bin distribution so that the points are clearly distributed in single bins, not spread over several bins, it is more likely that neighboring bins contain data points that, when taken together, constitute a mode. (See *Figure 3.106*.)

Figure 3.106 *Data Point Distribution in Bins*



In *Figure 3.106*, Scan A shows that the major distribution of points lie clearly in Z Min, Z Mid, and Z Max. The histogram of this distribution would be clearly presented in three ranges. However, in Scan B, the distribution for the Z Mid is between two bins. One bin near the center has 9 data points while its neighbor has 5 points. The user might want this distribution of points to be considered together as a mode. This is where the **Percentage for Qualifying Neighboring Bins** is used.

Figure 3.107 *Histograms of Scans A and B*

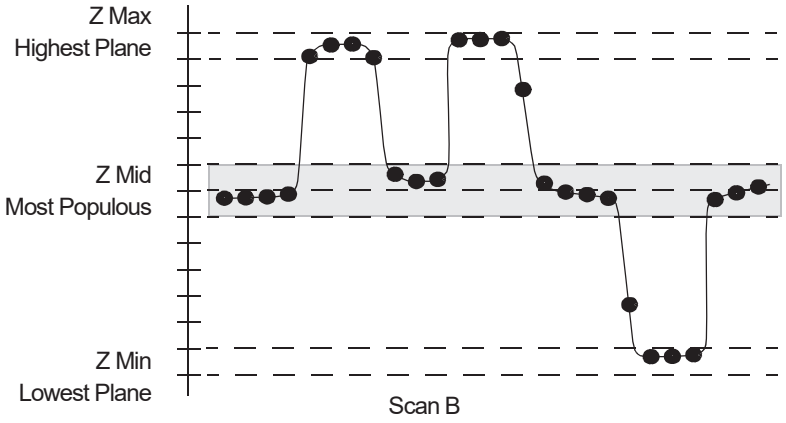


The user can set a percentage factor such that, if the bin containing the most data points (reference bin) has a neighboring bin that contains the user set percentage of the number of data points in the reference bin, it is also considered as part of the same mode and used in the leveling procedure.

EXAMPLE:

Using *Figure 3.106*, Scan B, if the user chose **Most Populous Plane** as the reference, and selected 50% as the **Percentage for Qualifying Neighboring Bins**, the system would check each mode in the scan data to determine which contains the highest number of data points. The modes would be comprised of bins or sets of bins, where a bin with a significant number of data points has one or more neighbors that contain at least 50% of the data points that it has. The mode with the highest number of data points is then considered to be the Most Populous Plane and is used in the leveling process. (See the shaded area in *Figure 3.108*, Scan B.)

Figure 3.108 *Multiple Bins (Mode) Used to Define a Plane*



Leveling Reference

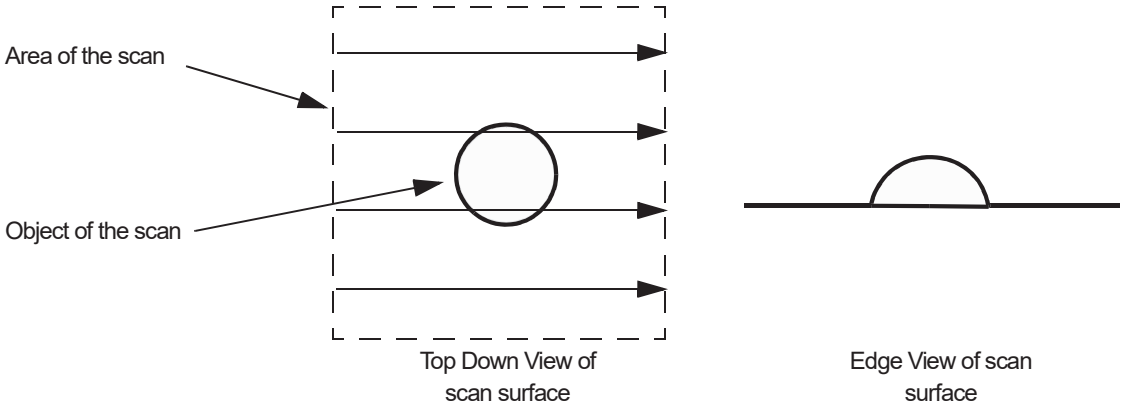
Three reference planes exist, from which one must be chosen to level the scan. Two of the planes are easy to understand and use; the Highest Plane and Lowest Plane.

- Highest Plane – Referring to *Figure 3.108*, the Highest Plane corresponds to the data set in the Z Max range (or mode if looking at the histogram).
- Lowest Plane – In the same illustration, the Lowest Plane corresponds to the data set in the Z Min range.

The third plane, Most Populous Plane, is more difficult to deal with and, depending on the topography of the sample, could lead to inconsistent results. The following illustrations describe the most common scan situations and the possible difficulties associated with using the Most Populous Plane for leveling and data analysis.

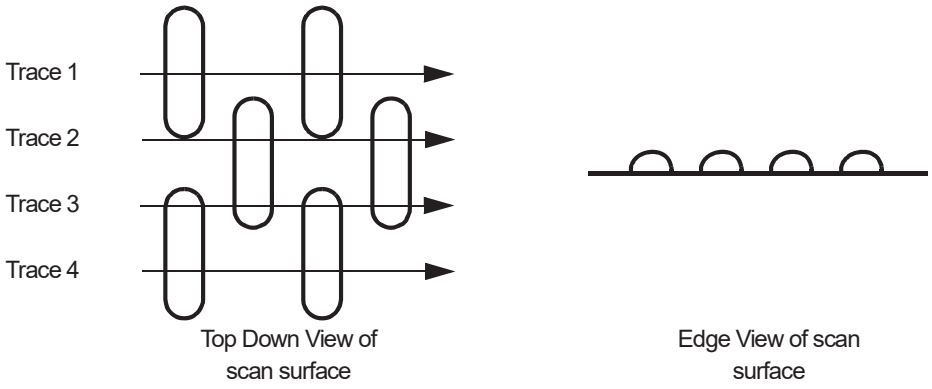
The Scan illustrated in *Figure 3.109* would be an acceptable candidate for Most Populous Plane. This scan is of a single attribute with a relatively large surface area surrounding it. No matter which scan trace is used, the sample surface level, in this case the Lowest Plane, would also be the Most Populous Plane. Either the Lowest Plane or the Most Populous plane could be used for leveling.

Figure 3.109 *Flat Surface Scan of a Single Object*



The scan illustrated in *Figure 3.110* would not be an acceptable candidate for Most Populous Plane. This scan has four traces that would give different data sets depending on which trace was used to level the scan. If Most Populous Plane was chosen as the leveling reference, traces 1, 2, and 4 would level the trace on the Lowest Plane of the scan. Trace 3 would level the trace on the Highest Plane of the scan. This would change the way the data is analyzed. The depths calculated from either of its two neighboring scans would be very different.

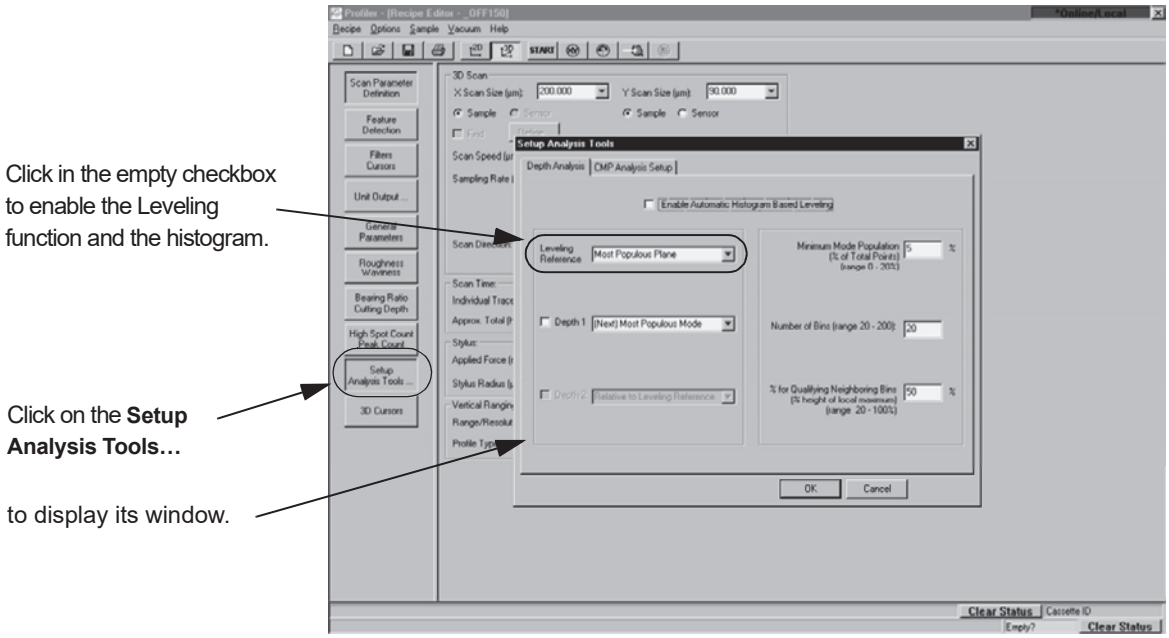
Figure 3.110 *Most Populous Plane Trace Variation*



Opening the Setup Analysis Tools Dialog Box

From the Recipe Editor, click on the Setup analysis tools button to open the Setup Analysis Tools dialog box. (See *Figure 3.111*.)

Figure 3.111 *Setup Analysis Tools Dialog Box*



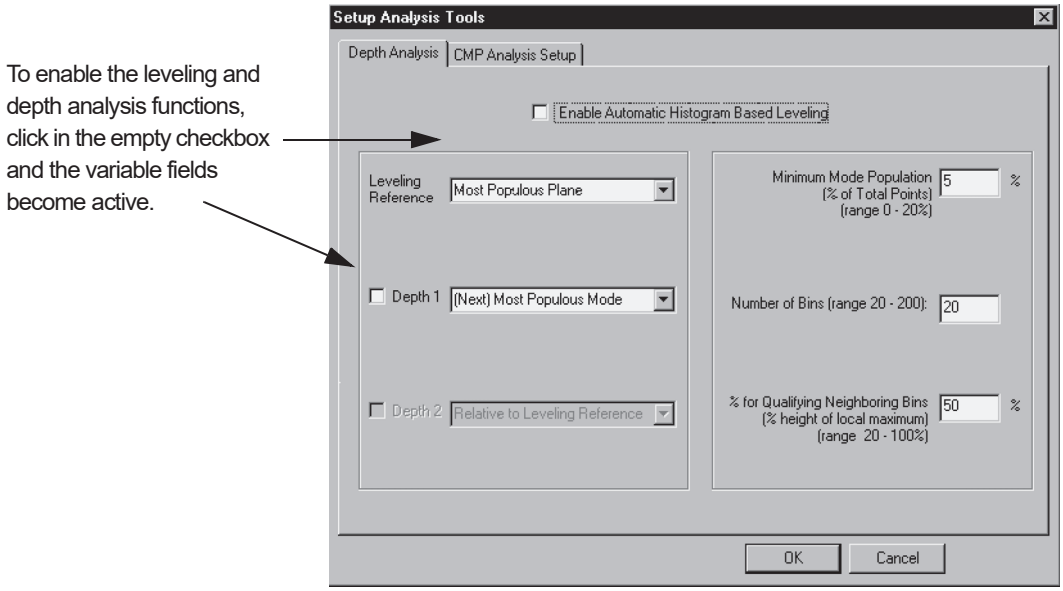
Setup Analysis Tools – Leveling

The Setup Analysis Tool's Leveling function and the histogram are both enabled by clicking in the empty checkbox next to Enable Automated Depth Analysis. (See *Figure 3.111*.)

To activate them, use the following procedure.

1. From the Recipe Editor, click on **Setup Analysis Tools** to display the **Setup Analysis Tools** dialog box. (See *Figure 3.111*.)

Figure 3.112 *Enable Automatic Depth Analysis*



2. In the Setup Analysis Tools dialog box, click in the empty **Enable Automated Depth Analysis** checkbox. (See *Figure 3.112*.)

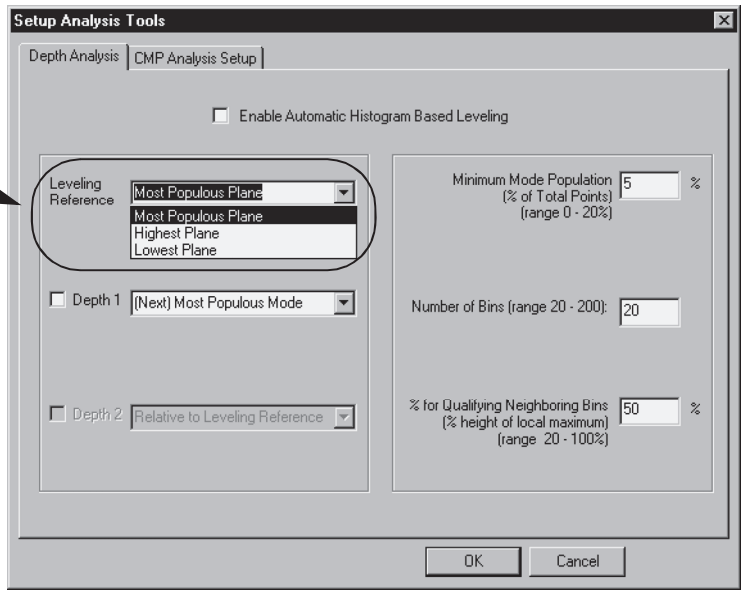
Change **Leveling Reference**

3. The **Leveling Reference** – The leveling attribute must be tied to the available data set. The leveling algorithms are set up to operate on one of three data sets (planes), **Most Populous Plane**, **Highest Plane**, and **Lowest Plane**.
   a. To select a data plane, click on the menu arrow next to **Leveling Reference**. (See *Figure 3.113*.)

b. Select the required data plane by clicking on it in the **Leveling Reference** drop-down menu. (See *Figure 3.113*.)

Figure 3.113 *Setup Analysis Tools – Leveling Reference*

To change the leveling attribute, click on the menu arrow next tot the **Leveling Reference** and choose the required attribute from the menu.



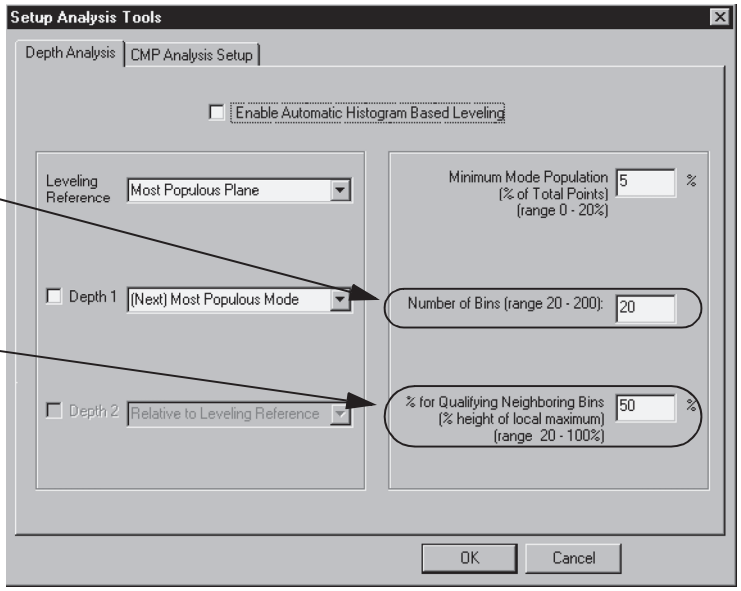
Change **Number of Bins**

4. The **Number of Bins** – highlight the current number in the Number of Bins variable box and enter the new number of bins to be used. (See *Figure 3.114*.)

   Remember, the more bins, the fewer number of data points each bin might contain. Be sure to carefully evaluate the distribution of data points in the bins so that the **% for Qualifying Neighboring Bins** can ensure that the proper number of points are included in the calculated modes for the leveling procedure.

NOTE: The available range for the number of bins is 20 – 200.

Figure 3.114 *Setup Analysis Tools – Setting the Number of Bins*



To set the Number of Bins, highlight the current number in the Number of Bins variable box and enter the new number.

Set the **% for qualifying neighboring bins** by highlighting the current percentage in the variable box and entering the new one.

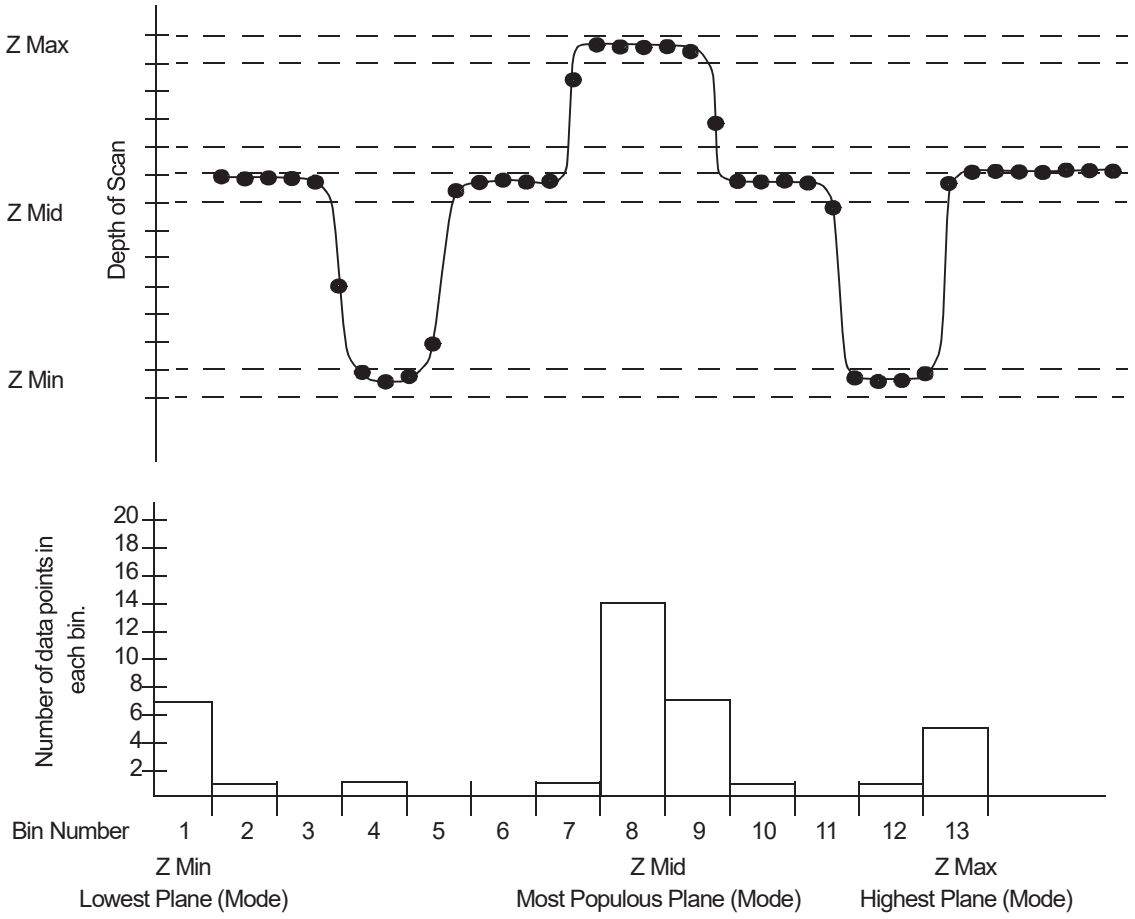
Change **% qualifying neighboring bins**

5. **% for qualifying neighboring bins** – Highlight the current percentage, in the **% for qualifying neighboring bins** variable box, and enter the new percentage. (See *Figure 3.114*.)

   Remember, the number of bins is divided up in equal spacing increments across the entire depth of the scan. The more bins, the more significant the **% for qualifying neighboring bins** becomes. This number, as well as the other attributes in this window can be adjusted after the scan data is collected; so assessing the data might help adjust the percentage to include all necessary data points.

   In the illustration presented in *Figure 3.114*, the bins in the mid range, bins 7-10, all contain data points. To isolate the data points that are to be considered as part of the mode, a percentage must be entered that only accumulates the desired data points. If Most Populous Plane was chosen as the reference, the system accumulates the total of all adjacent bins, in data point clusters, matching the percentage set in **% for qualifying neighboring bins**, and uses the totals to determine which bins constitute the Most Populous Plane. If 50% was set as the **% for qualifying neighboring bins**, the system would key in on bin #8 and include the contents of bin #9 because its contents were greater than 50% of the number of data points in bin #8. The data points in bins #7 and 10 would not be included because they were less than the required 50%. The combination of data points would show that this is the Most Populous Plane in the scan and perform the leveling and depth calculations from this data.

Figure 3.115 *Histogram of a Scan*



In the Histograms, the different planes (modes) are color coded for easy reference and identification. The Histogram is displayed in green. The major modes, when displayed, appear in red.

6. After all adjustments are complete, click **OK** to save the changes, or **Cancel** to discard the changes.

Diagnostic Options

This dialog box presents options that can be used to run diagnostic scans such as **No Motion** and **No Nulling** scans.

NOTE: Scans using these options should only be used by KLA–Tencor service personnel or applications engineers for diagnostic purposes only.

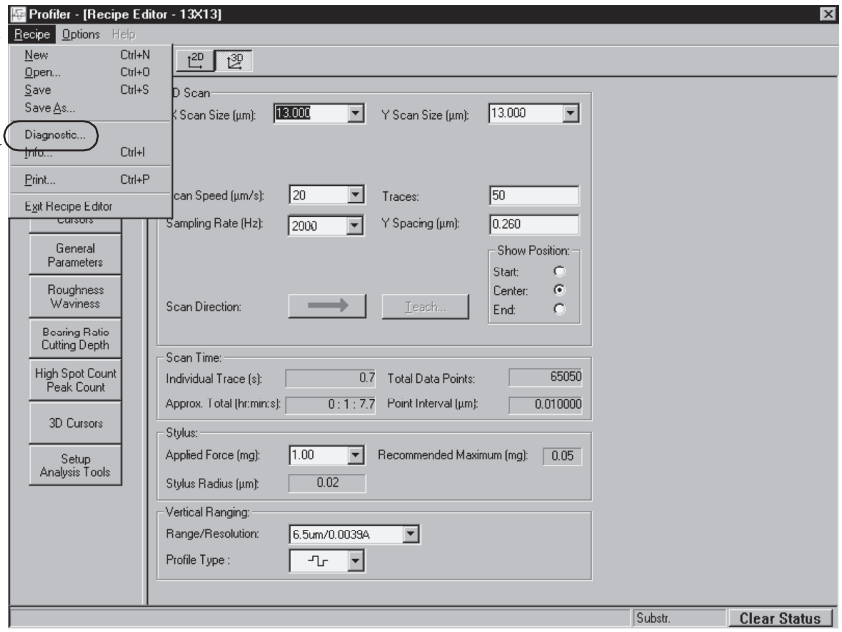
1. To display the **Diagnostic Options** dialog box:

a. Click on **Recipe** in the menu bar to display its menu,
b. Click on **Diagnostic...** from the drop-down menu. (See *Figure 3.116*.)

Figure 3.116 *Recipe Editor - Recipe Menu*

Step 1*a*. To access the Diagnostic Options dialog box, click on **Recipe** in the Menu Bar to display its menu.

Step 1*b*. Then click on **Diagnostic…** button.



2. This displays the **Diagnostic Options** dialog box. (See *Figure 3.117*.)

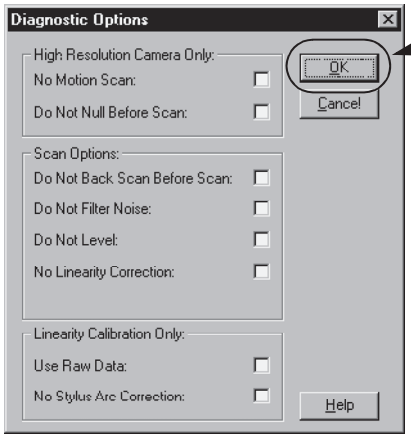
   To chose an option for a diagnostic scan, click in the empty checkbox next to the desired option. A check (✓) in the checkbox indicates that the option is chosen.

   Each **Option** is discussed below.

CAUTION: Each of the options is active for the recipe in which it is saved. If the recipe is used as a template to create other recipes, the option will remain intact unless turned off. This could create numerous scan data deviations from the expected scan results.

3. Click **OK** when all required options have been chosen. (See *Figure 3.117*.)

Figure 3.117 *Diagnostic Options Dialog Box*



Step 2 Click in the check box of the option that is to be used in the diagnostic. A check (✓) in the box means the option is chosen.

Step 3 Click on **OK** when the desired options have been chosen.

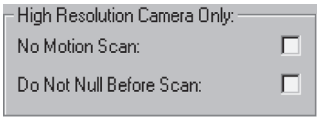
High Resolution Camera Only– Diagnostic Options

The diagnostic options presented here are used by the P-15 camera. In some systems supported by this software, more than one camera is used. In those systems, this set of options would only apply to the high magnification camera.

Table 3.29 *High Resolution Camera Only - Diagnostic Options*

Option	Description
No Motion Scan	During the scan, data is collected but the stage does not move. (See *Figure 3.118*.) **NOTE:** This scan is only available in 2D.
Do Not Null Before Scan	No movement of the elevator (for nulling) occurs before the scan is performed and the data collected. (See *Figure 3.118*.)

Figure 3.118 *High Resolution Camera Only: Diagnostic Options*



Scan Options

This is a set of miscellaneous scan related options.

Figure 3.119 *Scan Options: Diagnostic Options*

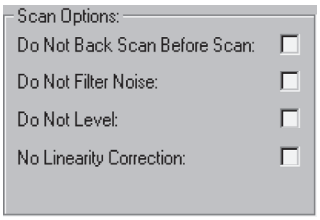


Table 3.30 *Standard - Diagnostic Options*

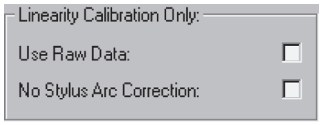
Option	Description
No Back Scan Before Scan	Back Scan is a technique where, immediately prior to the scan, the stage moves the scan start position back and begins the scan nulling and movement. The mechanical portion of the system has an opportunity to settle before actually reaching the beginning of the data collection. This option prevents the Back Scan positioning from taking place. (See *Figure 3.119*.)
No Noise Filter	This prevents postprocessing of the scan data with cutoff filters. (See *Figure 3.119*.)
No Leveling	This prevents postprocessing data leveling of scan data. (See *Figure 3.119*.)
No Linearity Correction	Only used during the Linearity Calibration. (See *Figure 3.119*.)

Linearity Calibration Only – Diagnostic Options

Table 3.31 *Linearity Calibration Only – Diagnostic Options*

Option	Description
Use Raw Data	Raw data from the scan is presented with no postprocessing; without scaling to the measurement range. **NOTE:** This option has no useful application apart from the Linearity Calibration.
No Stylus Arc Correction	Data from the scan is presented with no postprocessing arcal correction. **NOTE:** This option has no useful application apart from the Linearity Calibration.

Figure 3.120 *Linearity Calibration Only*



Saving Scan Recipes

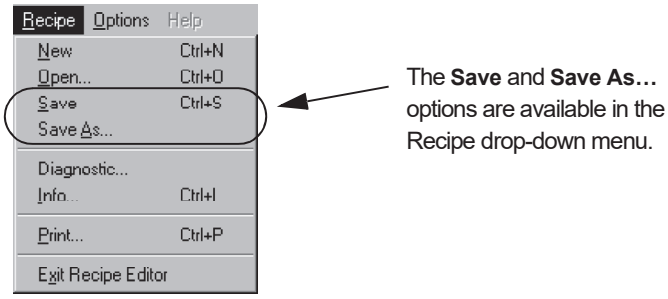
Options for Saving Scan Recipes

The recipes that are created using the **Recipe Editor** must be saved to capture the new or modified parameters. Two options available for saving a recipe are accessed in the **Recipe** drop-down menu are:

- **Save**, is used to either save changes to a current recipe, or to save the content of New recipe.
- **Save As**, is used when changes have been made to an existing recipe and the user wishes to preserve both the new recipe and the original one.

The two options are explained in detail later in this section. (See *Figure 3.121* and also *Figure 3.116 on page 3-106*.)

Figure 3.121 *Recipe Menu with Save and Save As… Options*



Recipe Naming Convention

The P-15 system's software allows for Scan and Sequence Recipe names that are 79 characters long. This allows the user adequate space to make names that describe the content of the recipes being named.

While the longer names provide greater flexibility for descriptive naming, several software display locations exist where the recipe names are displayed in truncated form. This could present difficulties when attempting to identify which recipe is actually represented by the truncated recipe name.

If a long name is to be used, make the first eight characters in the name reflect the recipe difference so its truncated version can be easily recognized in other screens.

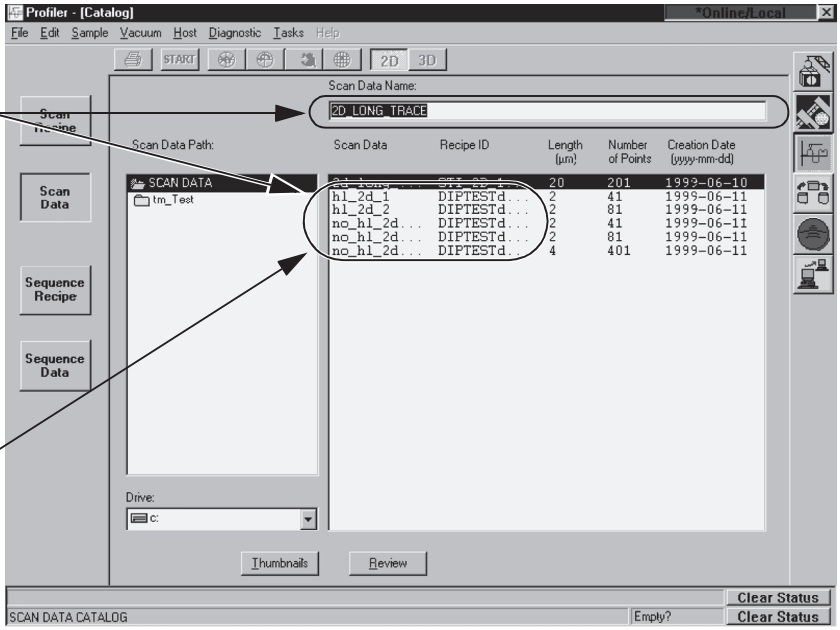
EXAMPLE:

If the first 8 or more characters of several Scan Recipes are identical, the following problem could arise when attempting to identify which recipe was used to create the scan data. (See *Figure 3.122*.)

Figure 3.122 *Catalog: Scan Data Screen*

When a Scan Data file is chosen (clicked on) it highlights and the **Scan Data** file name is totally displayed in the **Scan Data Name** display box. The Scan Recipe is not totally displayed, only the first eight characters of the name.

In the Recipe display portion of the **Catalog: Scan Data** screen, both the name of the Scan Data and the Recipe ID name are truncated. (See the note above.)



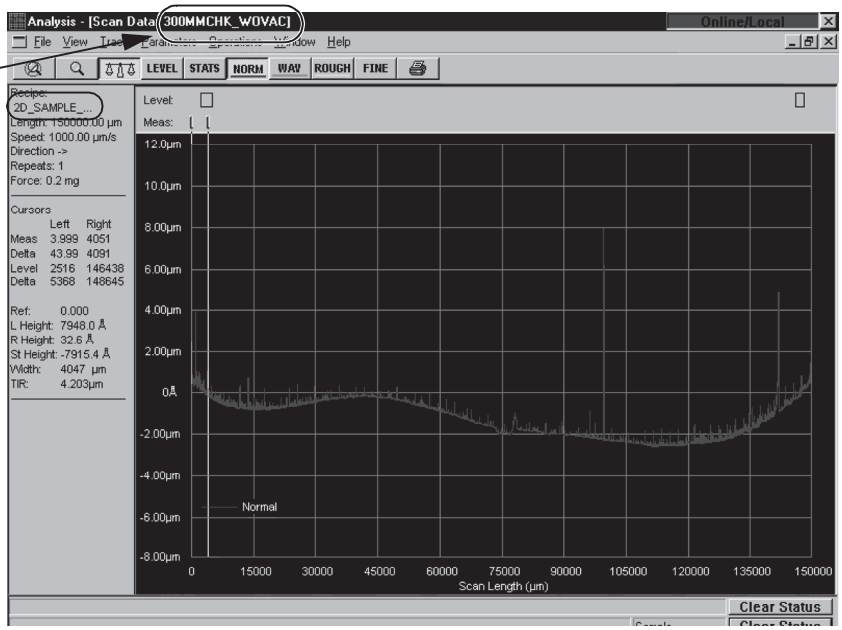
In *Figure 3.122* both the Scan Data name and the Scan Recipe name are truncated down to eight characters in the Scan Data file list. When the Scan Data file is clicked on, it highlights and the Scan Data file name is totally displayed (up to 74 of the 79 characters) in the Scan Data Name reference box. The Scan Recipe name is not displayed in total any place on this screen.

If the user attempts to discover the actual recipe name by opening the Scan Data File, the Analysis screen is opened and displays the Scan Data information. The Scan Data file name is completely displayed in the title bar but the Scan Recipe name is still truncated to 10 characters.

Figure 3.123 *Analysis Screen*

The Scan Data name appears totally displayed at the top of the screen.

The Scan Recipe, used to gather the data, is listed in truncated form (10 characters only).



If the scan recipes used to gather data have the same first 8 or 10 characters, it could be very difficult to tell which actual recipe was used to gather the data presented in the Scan Data file.

END OF EXAMPLE

Use the following procedure to name a Recipe.

- Use file names that contain different characters in the first 8 characters. (See EXAMPLE above.)
- Be sure to connect all words in the file name together. Use an underline "_" to separate the words.

  If the words are not connected as in *Figure 3.124*, a warning is generated. (See *Figure 3.125*.)

Figure 3.124 *Save Recipe As - Improper Name Format*

Notice the spaces between the words. This generates a system message. (See *Figure 3.125*.)

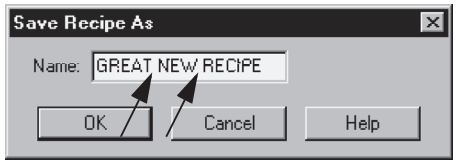


Figure 3.125 *Recipe Message Box*

The words need to be set together or separated by an underline "_" character. (See *Figure 3.126*.)

Figure 3.126 *Save Recipe As - Proper Name Format*

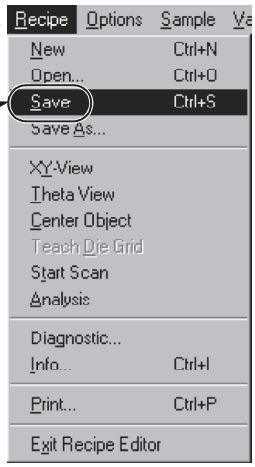
Notice that the spaces are filled in using the underline "_" character.

1. From the Recipe Editor screen, click on **Recipe** in the Menu bar to display its menu. (See *Figure 3.127*.)
2. Click on:
   a. **Save** - to save the changes to the current recipe. This immediately saves recipe with no further operator requirement.
   b. **Save As** - to preserve the original recipe unchanged and to save the changes as a new recipe. (See *Figure 3.127*.)

Figure 3.127 *Recipe Editor*

Step 1 Click on **Recipe** in the Menu Bar.

Step 2 Click on either **Save** to save changes in the current recipe, or **Save As** to preserve the current recipe unchanged and the changes in a new recipe.



3. If **Save As** is clicked, the **Save Recipe As** dialog box appears. (See *Figure 3.127*.)

4. Type in the new recipe name, making sure there are no spaces between words. (See *Figure 3.128*.)

Figure 3.128 *Save Recipe As Dialog Box*

Step 5 Enter the new recipe name and click on **OK** to enter the Recipe name into the Recipe file.

5. Click on **OK** to form the new recipe. (See *Figure 3.128*.)

Entering Comments

Introduction

This feature is designed for recording important comments about the recipe. The only field that is active for user input is the Comments: field. The other fields are automatically set by the system to reflect the specific recipe.

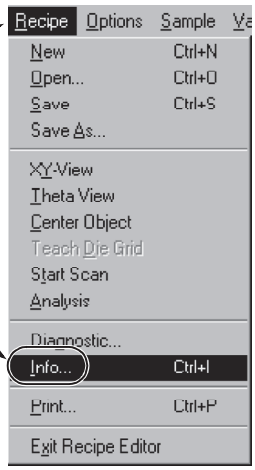
Procedure

1. Click on **Recipe** in the menu bar of the **Recipe Editor**.

Figure 3.129 *Recipe Editor*

Step 1 Click on **Recipe** to display its menu.

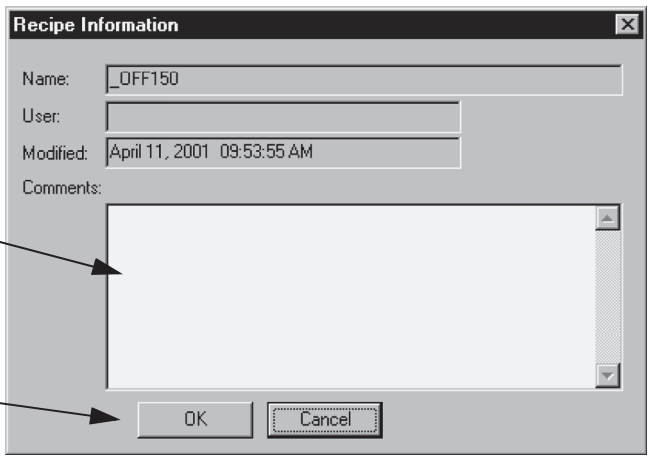
Step 2 Click on **Info** to display the Recipe Info dialog box.



2. The Recipe menu is displayed. Click on **Info** to display the **Recipe Information** dialog box. (ALTERNATIVE: Press **Ctrl + 1**.)

3. Click in the **Comments** text field and enter the information that is to accompany the recipe.

Figure 3.130 *Recipe Information Dialog Box*



Step 3 The cursor should be blinking in this field. Enter any required comments in the field.

Step 4 After comments have been added, click on **OK** to save them and close the dialog box.

4. When the information is entered, click on **OK** to save it and close the dialog box.

4

STYLUS CHANGE PROCEDURE

INTRODUCTION

Styli are available in various sizes for a variety of different scanning requirements. Each stylus is a delicate tool and requires careful handling.

Styli are color-coded to indicate radius. Check the color band on the stylus arm against the following table for the stylus radius.

Table 4.1 *Available L-Stylus Radius*

Color Code Band	Stylus Radius (μm)	Cone Angle (Deg.)
Red	12.5	60
Yellow	5.0	60
Green	2.0	60
Orange	2.0	45
Black[a]	0.3–0.8	85
Black[a]	0.1–0.2	85
Dual Black (Not recommended for the P-15)	0.03-0.05 (DuraSharp)	40

a. For radius values, refer to the SEM documents provided with the stylus.

This chapter describes:

PROXIMITY SENSOR ACTIVATION

Before beginning the procedure and subsequent calibrations, it is important that the Proximity Sensor settings be adjusted in order to ensure optimum system performance and to protect the sensor and stylus.

1. Ensure that the Proximity Sensor is being used during the following calibrations.

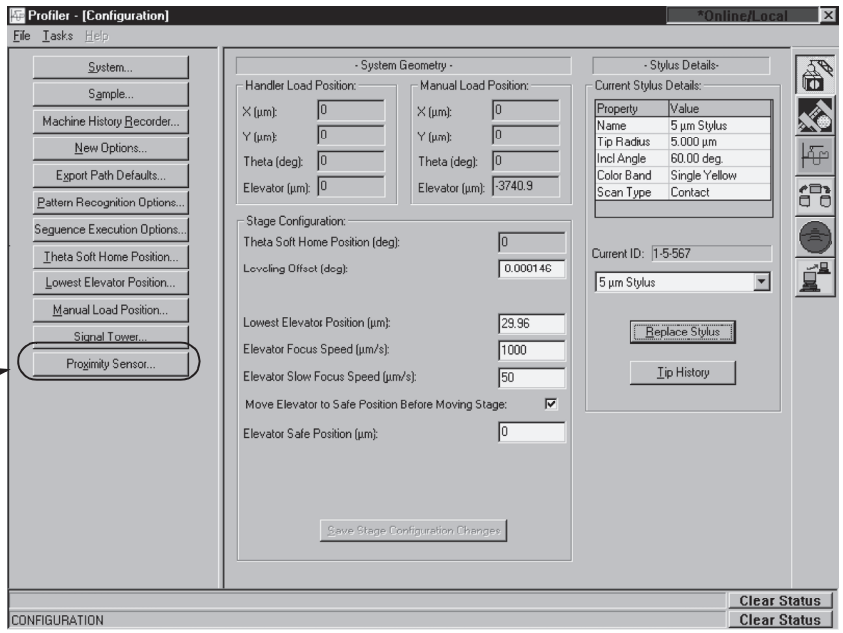
   Defining parameters used by the proximity sensor are set in the Proximity Sensor Configuration dialog box. To access it from the **Profiler – [Catalog]** screen, click on the **Configuration** icon. (See *Figure 4.1*.)

Figure 4.1 *Profiler [Catalog] - Click on the Calibration Icon*

Step 1 Click on the **Configuration** icon to display the **Configuration** screen.

2. In the **Configuration** screen, click **Proximity Sensor…** to display the **Proximity Sensor Configuration** dialog box. (See *Figure 4.3*.)

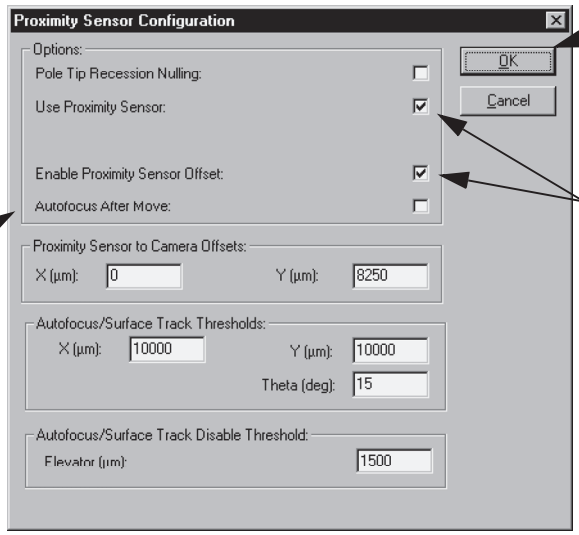
Figure 4.2 *Configuration Screen*



Step 2 Click on the **Proximity Sensor…** button to open the Proximity Sensor Configuration dialog box.

3. In the **Proximity Sensor Configuration** dialog box, click in the empty checkbox next to **Use Proximity Sensor**. (See *Figure 4.3*.) The ✓ in the checkbox enables the option so the system uses the **Proximity Sensor** to stop the head from contacting the sample during the null on a sample surface, thus helping prevent damage to the sample or the stylus.

Figure 4.3 *Proximity Sensor Configuration Dialog Box*



Step 6 After all changes are complete, click **OK**.

Step 3 Click in the empty checkbox next to **Use Proximity Sensor** and (**Step 4**) **Enable Proximity Sensor Offset** to enable these options. A check (✓) in the box indicates that they are enabled.

Optional: Click in the empty checkbox next to **Autofocus After Move** to enable this option. A check (✓) in the box indicates that it is enabled.

4. The **Enable Proximity Sensor Offset** option is very important when measuring small artifacts that are on elevated surfaces or near the edge of the sample. This ensures that the null and autofocus are taking place at the same Z level as detected by the proximity sensor. In addition, it protects the sensor and head from damage, especially near the wafer edge.

   Click in the empty checkbox to put a ✓ in it. This enables the Proximity Sensor Offset option. (See *Figure 4.3*.)

5. The **Autofocus After Move** option is designed null and focus on the sample in the XY view screen. It does require time to perform this function, so it can be turned off for running sequences and other procedures where the user does not need to see the image.

   Click in the empty checkbox to put a ✓ in it. This enables the Autofocus After Move option. (See *Figure 4.3*.)

6. Click **OK** to close the **Proximity Sensor Configuration** dialog box.
7. To save the changes made in the **Configuration** screen, click on **File** from the tool bar at the top of the screen to display the **File** menu.
8. Click on **Save** from the **File** menu.
9. Exit the **Configuration** screen by clicking on the small icon in the top left corner of the screen (to the left of the word Configuration), then from the drop-down menu click on **Close**.

STYLUS REMOVAL AND REPLACEMENT

The following discussion contains procedures for changing the stylus in the sensor assembly of the P15 system.

Stylus replacement in the P-15 system is relatively simple. ***Important:***

Use only an approved stylus from KLA-Tencor.

Do not modify the measurement head in any way. If, while using the prescribed procedure, there is difficulty in mounting the stylus, call KLA-Tencor Customer Service.

Know the stylus type and radius for input later in the procedure.

Follow the instructions as presented in this section to avoid omitting steps.

CAUTION: The stylus tip is very fragile! When removing the stylus from its shipping container, use stainless tweezers (422320) to hold the arm while gently peeling back the foam. Grasp the arm in the center section and lift the stylus out tip first. To place the stylus back in its shipping container, place the rounded end into the round end of the holder and slowly rotate the tip end down. Release the tip only when it is properly positioned in the grove.

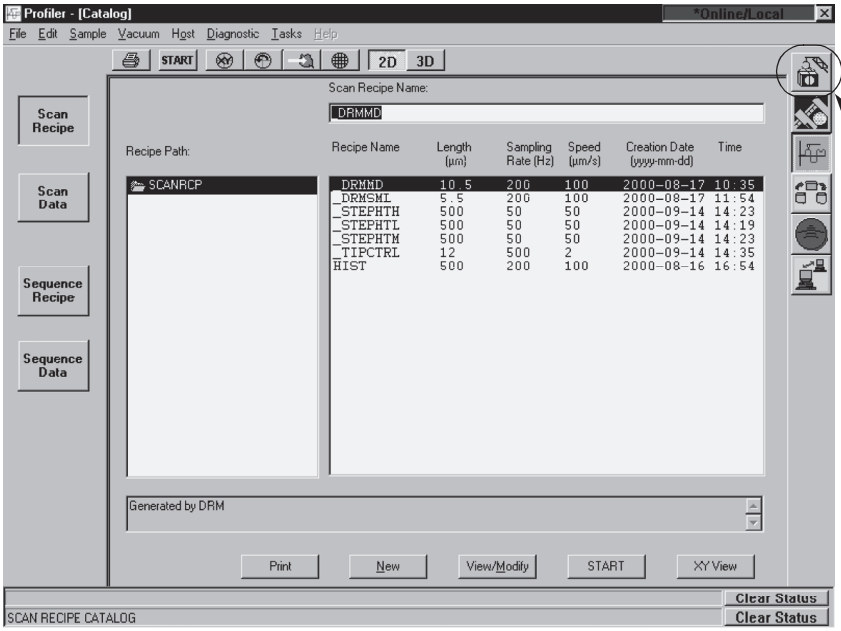
The procedure consists of six parts:

- Stylus removal procedure
- Stylus replacement procedure
- Scan Position Offset Calibration.

Stylus Removal

1. From the **Profiler [Catalog]** screen click on the **Configuration** icon to display the **Configuration** screen. (See *Figure 4.4*.)

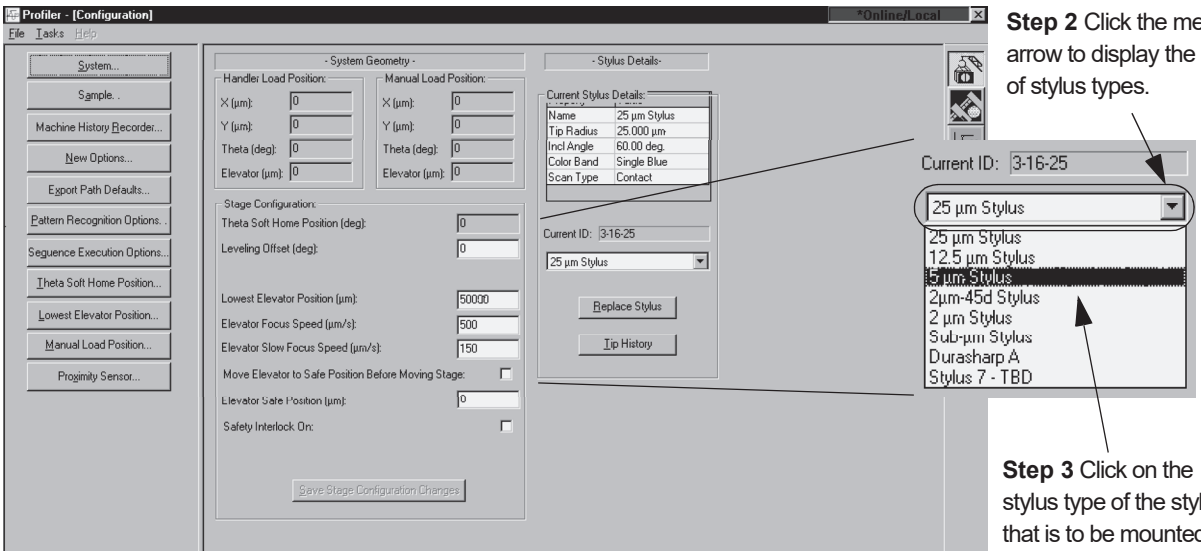
Figure 4.4 *Profiler [Catalog] - Click on the Calibration Icon*



Step 1 Click on the **Configuration** icon to display the **Configuration** screen.

2. From the **Configuration** screen click on the menu arrow to the right of the stylus type variable box to display its menu. (See *Figure 4.5*.)

Figure 4.5 *Stylus Force Calibration Button*

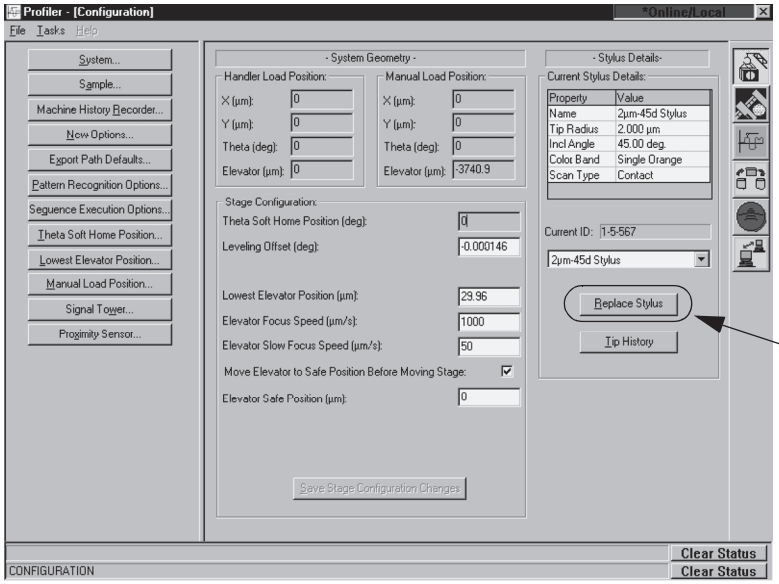


Step 2 Click the menu arrow to display the list of stylus types.

Step 3 Click on the stylus type of the stylus that is to be mounted.

3. Click on the stylus type that will replace the current stylus. (See *Figure 4.5*.)
4. Click on **Replace Stylus** to display its dialog box. (See *Figure 4.6*.)

Figure 4.6 *Configuration Screen*



Step 4 To begin the stylus replacement procedure, click **Replace Stylus** to display its dialog box.

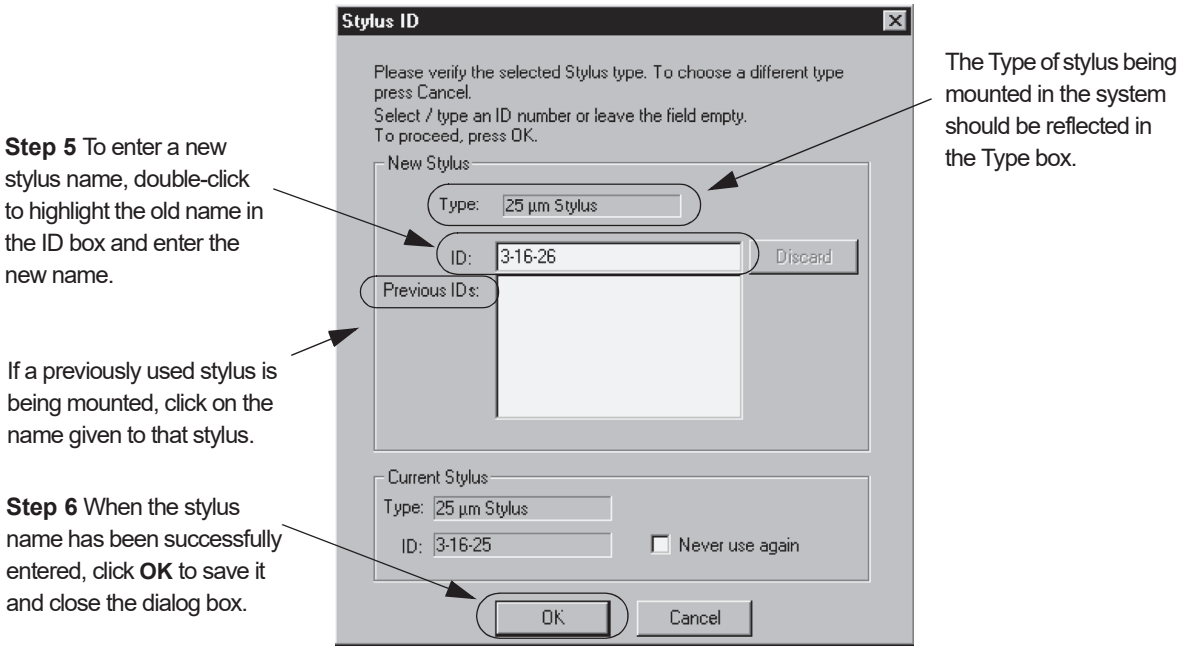
5. To make it easier to track stylus performance, the system provides an opportunity to name the stylus. The type of stylus has already been set before moving to this screen (see Step *3.*), and is identified in the **Type** variable box. This variable cannot be changed in this dialog box, only in the Configuration screen. The name identifies the specific stylus of the Type referred to in the **Type** variable box.

   The **Stylus ID** dialog box is displayed. (See *Figure 4.7*.) It contains the name of the stylus and a list of previously identified styli of the Type referenced in the **Type** variable box.

   To identify a new stylus: When using a new stylus, double-click in the ID variable box and enter the new name.

   To enter the name of previous stylus: When mounting a previously used stylus, click on the name of the stylus from the **Previous ID's** list. The name should appear in the **ID** box.

Figure 4.7 *Stylus ID Dialog Box*

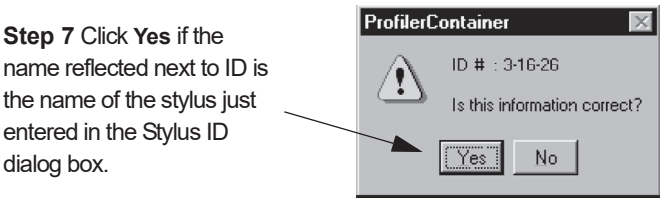


6. When the new name is entered, click **OK** to save it and exit the dialog box. (See *Figure 4.7*.)
7. The profiler message box is displayed inquiring if the name displayed is the correct stylus name. Click **Yes** to affirm the name or **No** if the name is incorrect and needs to be changed.

   When **Yes** is clicked, the system head is automatically raised to the manual load height for easy access to the stylus.

   (If **No** is clicked, it is necessary to name the stylus again.)

Figure 4.8 *Message Box for Stylus Name Affirmation*

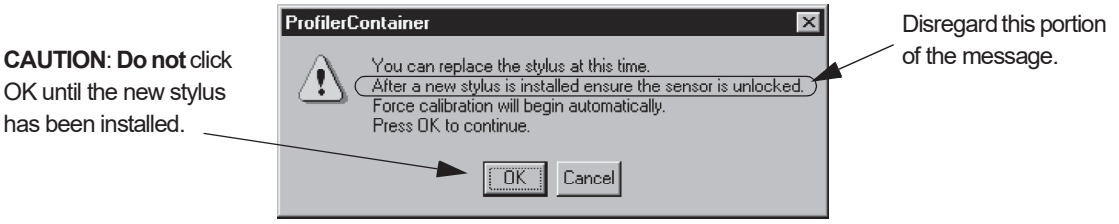


8. After **Yes** is chosen, another message box is displayed. (See *Figure 4.9*.) This box states that the stylus can be changed.

   Notice that the message box contains a caution telling the user to "ensure the sensor is unlocked." Disregard this part of the message, it is not for the MicroHead II sensor assembly.

   DO NOT CLICK OK UNTIL THE STYLUS HAS BEEN CHANGED.

Figure 4.9 *Message Box for Stylus Change Permission*

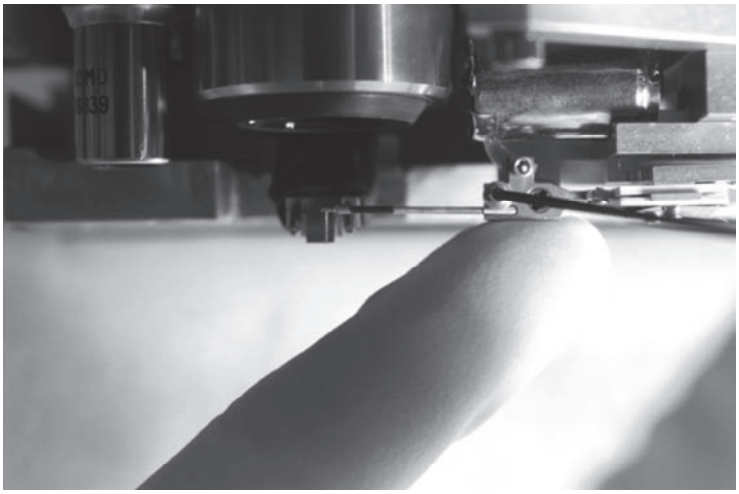


9. Open the Stage door.

CAUTION: Do not operate the stage or any motor driven component **with the door open** or the system will have to be rebooted.

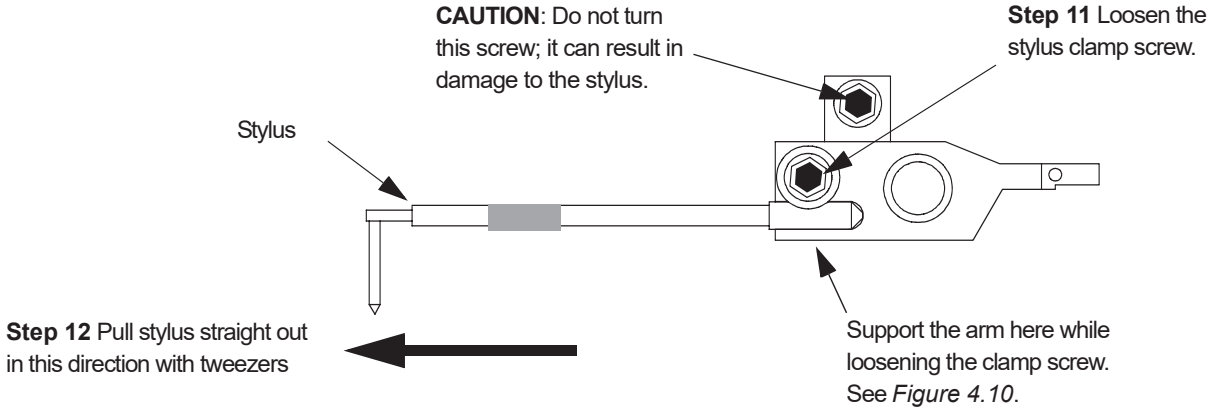
10. Loosen the thumbscrew holding the stylus wrench to the side of the head and slide the wrench out of its holder.
11. The head of the stylus clamp screw is visible from the front of the instrument. Place a finger under the Stylus Mount to support it while the screw is being loosened. Loosen the screw by inserting the stylus wrench and turning the wrench counterclockwise 1/2 turn. Be careful to apply turning torque only. Do not push against the screw head any harder than is necessary to seat the wrench. (See *Figure 4.10* and *Figure 4.11*.) Do not remove the screw.

Figure 4.10 *Supporting Stylus Mount During Stylus Change*



12. With the stylus clamp screw loose, take hold of the stylus with tweezers and pull gently straight to the left until the stylus comes free. (See *Figure 4.11*.)

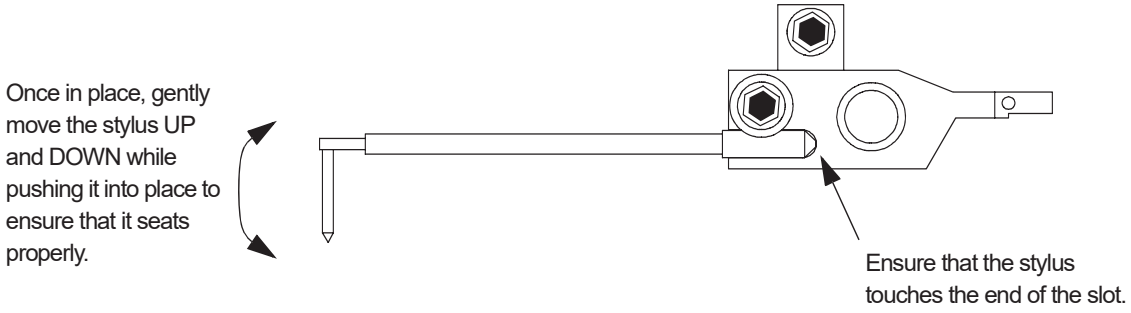
Figure 4.11 *Sensor Assembly - Loosening Stylus Clamp Screw*



Stylus Replacement

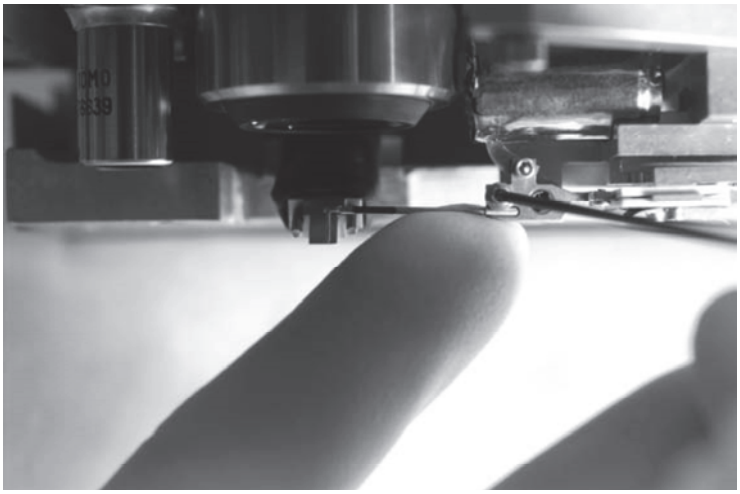
1. Using tweezers, take hold of the new stylus with the tip pointing downward toward the stage. Insert the long arm of the stylus into the support groove in the stylus arm. Gently maneuver it into the slot. Once in the slot, move it up and down gently to ensure that it reaches the end of the slot and seats properly. (See *Figure 4.12*.)

Figure 4.12 *Sensor Assembly - Seating the New Stylus*



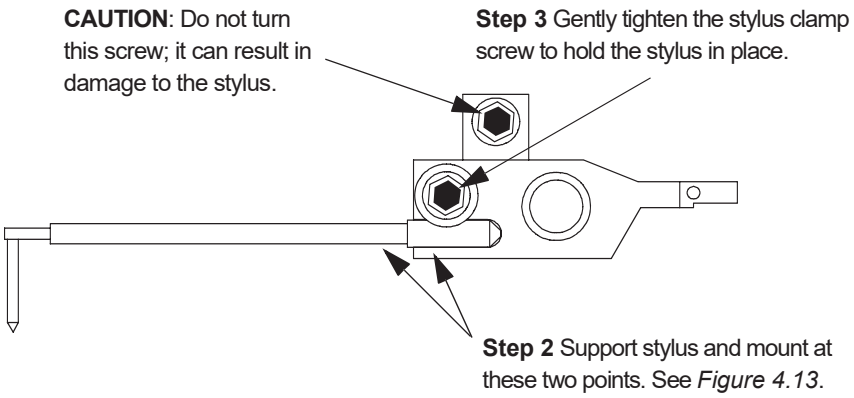
2. Support the **stylus mount (arm) and stylus** with a finger to protect it from damage while tightening the mounting screw. (See *Figure 4.13*.)

Figure 4.13 *Supporting Stylus and Mount During Tightening Procedure*



3. While supporting the stylus and the stylus arm, gently tighten the clamp screw to hold the stylus in place. Do not over tighten or damage can occur to the stylus arm pivot. (See *Figure 4.13* and *Figure 4.14*.)

Figure 4.14 *Sensor Assembly - Seating the New Stylus*

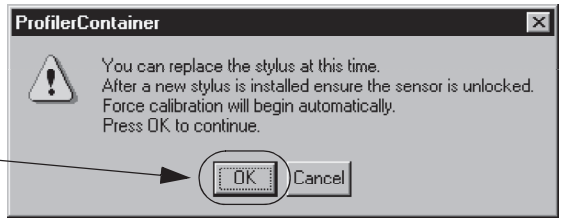


4. Remove the wrench from the clamp screw and replace it in its mount. Tighten the thumbscrew to hold the wrench in place.

5. When the stylus installation is complete, click **OK**. (See *Figure 4.15*.)

Figure 4.15 *Message Box for Stylus Change Permission*

Step 5 When the stylus installation is complete, click on **OK**.



6. The system performs an Applied Force calibration.

Scan Position Offset Calibration

Introduction

As soon as the Applied Force calibration is complete, the Scan Position Offset procedure is initiated. The Scan Position Offset Calibration procedure scans for data that it then uses to calculate the X-, Y-axis offsets from the optics and stylus, for positioning the sample stage.

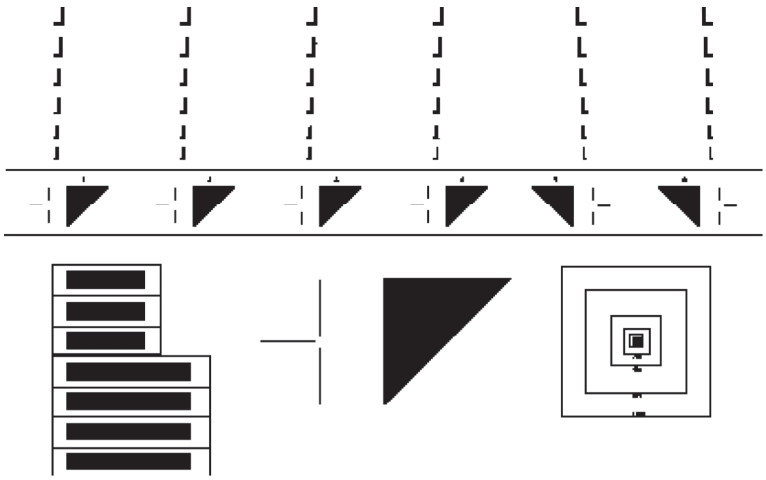
For the standard styli this procedure is performed in the following order:

1. 150 μm (standard) calibration
2. If the 150 μm scan fails to locate the triangle, then the 500 μm (backup) calibration is performed.
3. If the 500 μm was performed successfully, the 150 μm calibration must be performed again.

Calibration Procedure

Use the Stylus Alignment Tool (KLA-Tencor Part Number 219517 – see *Figure 4.16*) to perform the Scan Position Offset Calibration and determine the distance that the stylus tip is offset from the crosshair overlay in the XY View window.

Figure 4.16 *KLA-Tencor Stylus Alignment Tool*



1. A message box is displayed requesting the user to place the Scan Position Offset tool on the stage. (See *Figure 4.17*.)

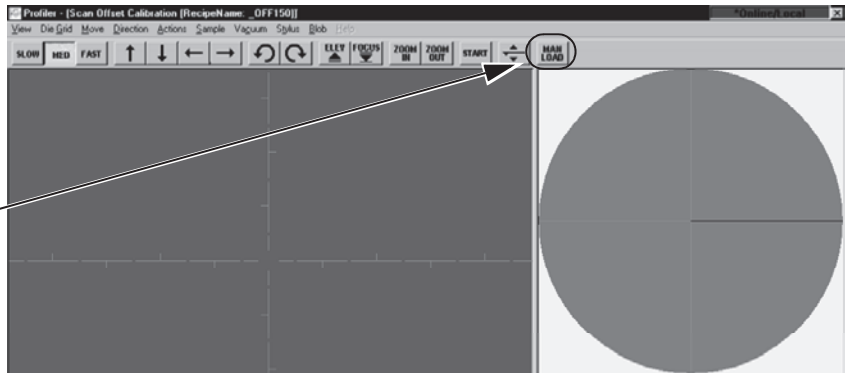
   Figure 4.17 *Message Box Requesting SPO Standard Placement*

2. Open the stage door.

Figure 4.18 *Manual Load from the Scan Offset Calibration Window*

Step 10 After loading the Stylus Alignment Tool, click on **MAN LOAD** again to send the stage back under the stylus.



3. Place the **Stylus Alignment Tool** precisely in the center of the stage, squarely positioned with respect to the XY axis.
4. Turn the vacuum ON using the switch on the upper left inside door frame.

NOTE: The Vacuum menu in the screen's menu bar is not functional. It does not effect the stage vacuum.

5. Close the stage door.
6. Click OK in the message box. (See *Figure 4.17*.)

   The **Scan Offset Calibration Option** dialog box is displayed (see *Figure 4.19*) on top of the Calibration screen.

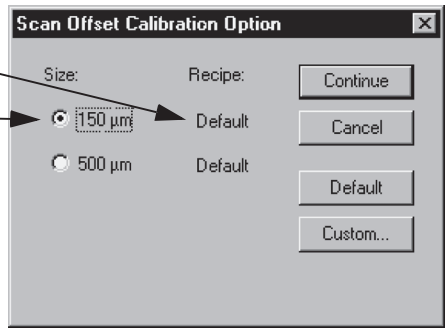
   Two columns present the two options used to set up the Scan Offset Calibration. The first column is the **Size** column. It is used to determine the length of the step that is to be scanned and, therefore, which triangle the scan is to be performed on. If the step is 150 µm, the system uses the 300 µm triangle. If the step is 500 µm, the system uses the 1000 µm (1 mm) triangle.

7. Choose **150 µm** (standard) to continue with the calibration. (See *Figure 4.19*)

Figure 4.19 *Scan Position Offset Calibration Options dialog box*

Step 8 Choose Recipe type: **Custom** or **Default**

Step 7 Click on **150 µm**.

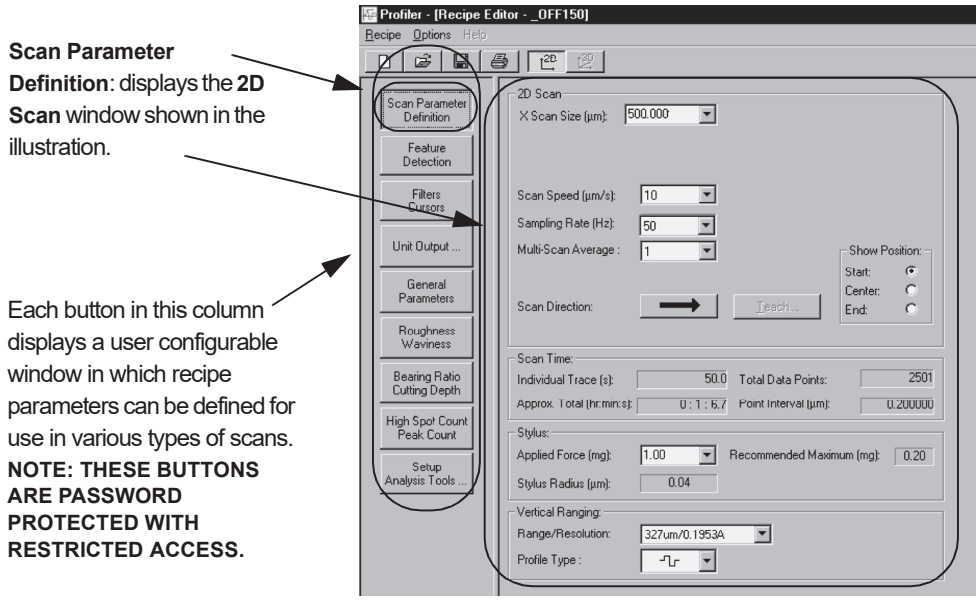


8. **Use the Default recipe unless there is a very good reason not to**.

   RECIPE TYPES. Two calibration options exist in the **Scan Offset Calibration Option** dialog box. Each option provides the user with the opportunity to choose between using a default recipe or to create/use a custom recipe. Default and Custom recipes are explained below:

   - **Default**: This recipe is designed to operate with a scan speed and stylus force setting that is safe for the stylus. The default settings are the KLA-Tencor recommended recipe settings for all the calibrations.
   - **Custom**: This recipe type offers the user the option to customize recipe parameters to meet specific scan requirements. In the Recipe Editor there are seven windows, each with configurable parameters. (See *Figure 4.20*.) For the **Scan Position Offset Calibration**, the only **Recipe Editor** window necessary is the **Scan Parameter Definition** that appears when the editor is first opened (see *Figure 4.23*). When chosen, the **Scan Parameter Definition** button (in the top left corner of the screen, circled in *Figure 4.20*) appears to be indented.

Figure 4.20 *Window Buttons - _OFF150- Recipe Editor*



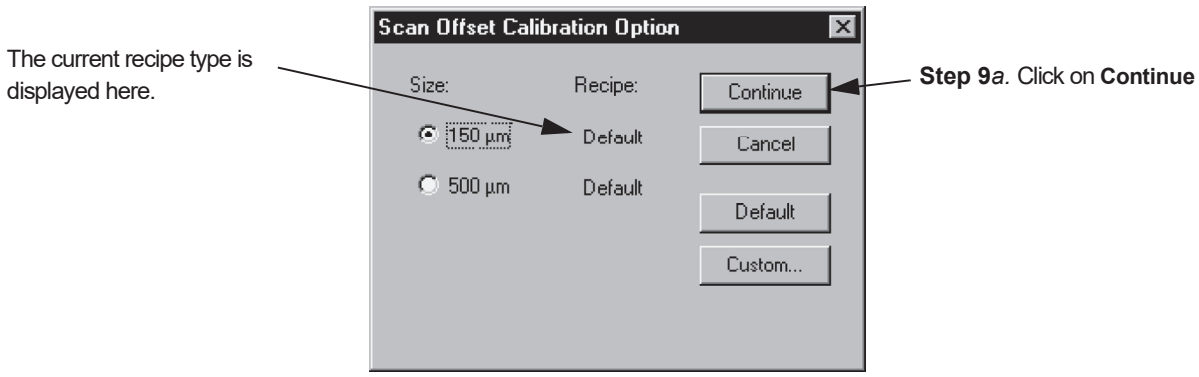
9. The recipes are set as follows:

CAUTION: KLA-Tencor recommends using the Default recipes unless there is a very good reason for creating a custom recipe.

To use the currently selected recipe:

a. To use the calibration recipe indicated to the right of the **Size** selection (see *Figure 4.21*), click **Continue** to proceed.

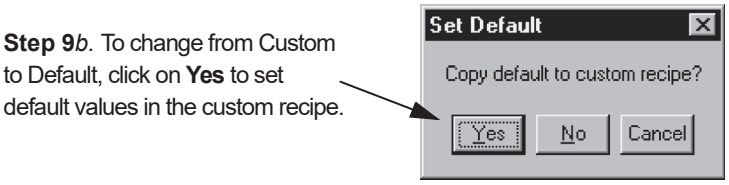
Figure 4.21 *Scan Position Offset Calibration Options dialog box*



To change the recipe from Custom to Default

b. To apply the **Default** recipe when **Custom** is indicated, click on **Default**. The message box, "**Copy default to custom recipe?**" appears. Click **Yes** in the message box to replace the parameters in the custom recipe with default values. (See *Figure 4.22*.)

Figure 4.22 *Set Default Dialog Box*



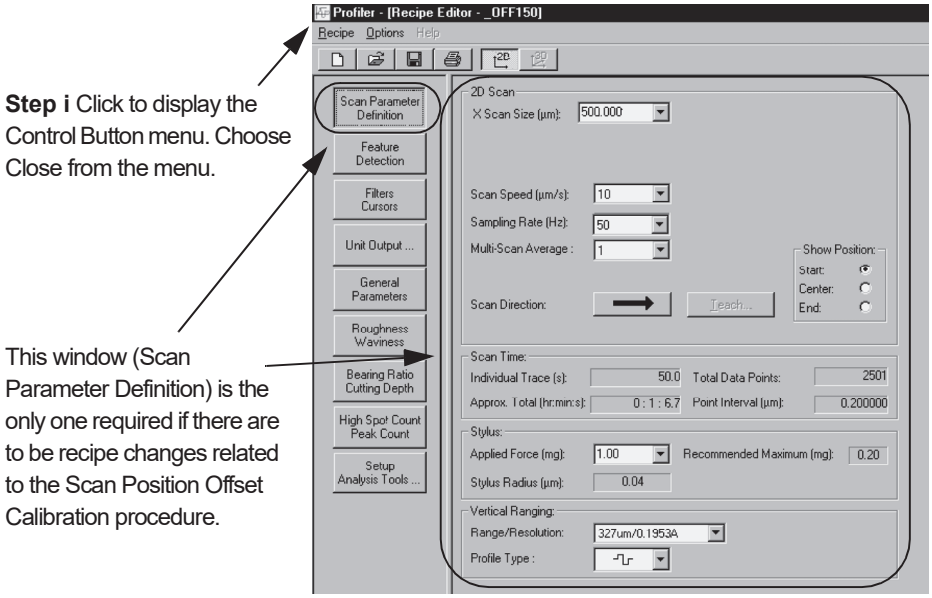
To change the recipe from Default to Custom

c. To apply a **Custom** recipe when **Default** is indicated, or to modify the custom recipe that is indicated, click **Custom**. The **Recipe Editor** opens, displaying the custom recipe. Change the parameters as required. (See *Figure 4.23*.)

   i. Close the **Recipe Editor** by clicking on the control button in the upper left corner and choosing **Close** from the drop-down menu. (See *Figure 4.23*.)

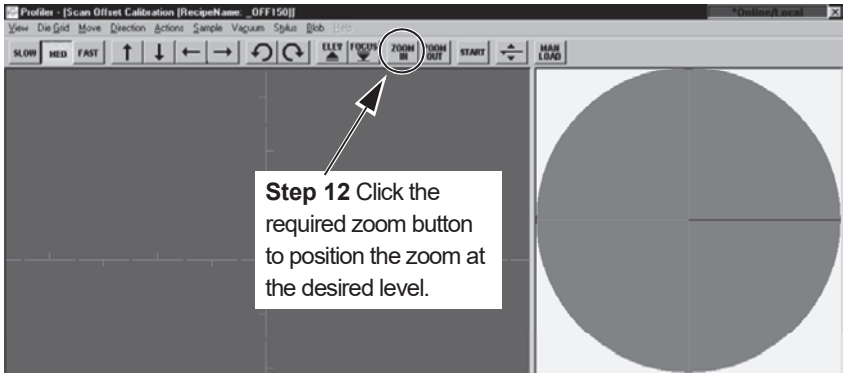
ii. If the new parameter values were not already saved, a dialog box requires the user to choose between the save options before exiting the Recipe Editor. Choose Save Changes to set the changes to the Custom recipe so they are used in the scan.

Figure 4.23 *Scan Parameter Definition - **_OFF150** - Recipe Editor*



10. From the **Scan Offset Calibration** screen, click **MAN LOAD** in the tool bar to move the stage back beneath the stylus. (See *Figure 4.18*.)

Figure 4.24 *ZOOM IN - Scan Offset Calibration*



11. (**BEFORE CONTINUING** see **CAUTION** below.) Click **FOCUS** in the tool bar. The Stylus Alignment Tool's surface image comes into focus. (See *Figure 4.24*.)

CAUTION: As the stylus lowers toward the Stylus Alignment tool, watch carefully to ensure that both the proximity sensor and the stylus come down on the tools measurement surface. With the Proximity Sensor Offset option chosen in the Proximity Sensor Configuration box, the proximity sensor is coming down directly on the position where the measurement is to be made. If the stylus and the sensor are not descending directly onto the stylus alignment tool's measurement area, press the Space Bar on the computer keyboard or a mouse click, to stop the stylus descent. Manually relocate the tool under the stylus. Click on **FOCUS** again to resume the procedure.

12. The zoom setting should be the same as that at which the scans are performed. KLA-Tencor recommends that the optics be zoomed all the way out (set at 0), or that the desired zoom setting be locked. (See *Saving the Current Zoom Position* on page 5-12.)

    To zoom in or zoom out, click and hold the correct button until the optics are at the required zoom setting. (See *Figure 4.24*.)

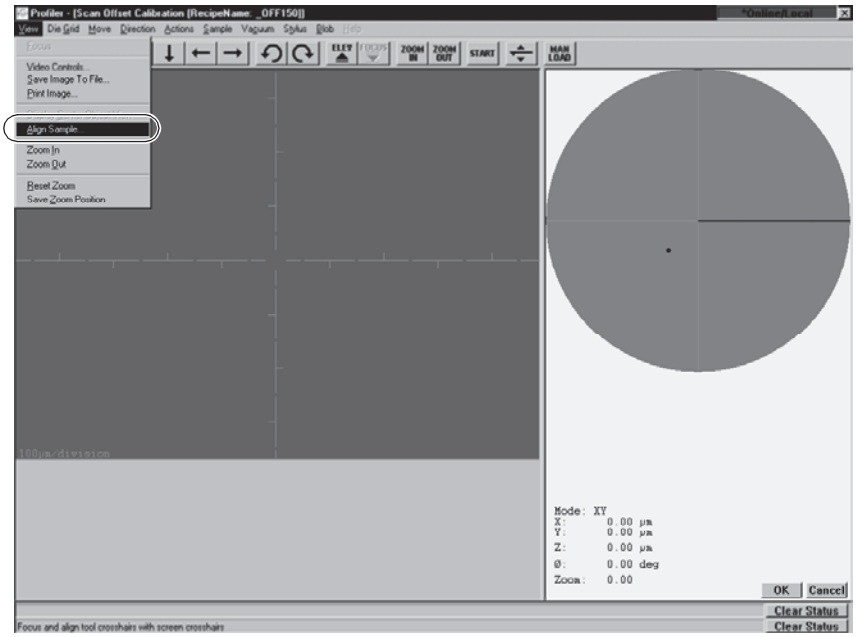
BEGIN Align Sample Procedure

13. The Stylus Alignment Tool must be aligned with respect to the X-, Y-axis in order for the calibration to be as accurate as possible. Click on **View** in the menu bar to display its menu. (See *Figure 4.25*.)
14. Choose **Align Sample…** from the menu. (See *Figure 4.25*.)

    This displays the Alignment Angle Dialog Box. (See *Figure 4.26*.)

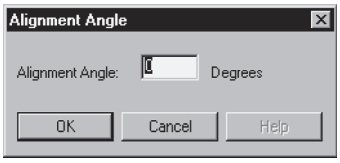
Figure 4.25 *View Menu with Align Sample Chosen*

Step 13 Click on **Align Sample…** to begin the sample alignment procedure.



15. In the Alignment Angle dialog box, leave the setting at the default, "0" and click **OK** to accept the alignment angel of 0°. (See *Figure 4.26*.)

Figure 4.26 *Alignment Angle Dialog Box*



The prompt at the bottom of the screen now says,.

Click the left mouse button to teach the first point

16. Use the arrow buttons to locate the border line between the 300 µm triangles and the 1000 µm triangle. Still using the arrow buttons, follow the line to the left side of the tool. (See *Figure 4.27*.)
17. Move the cursor to the line and click precisely on the line.

    The prompt at the bottom of the screen now says,

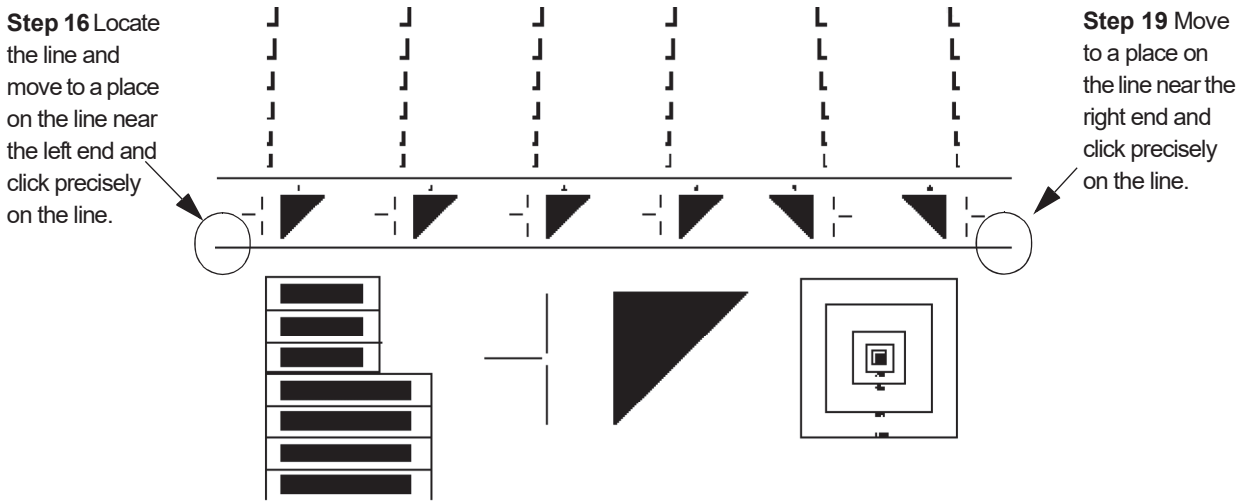
    Press OK to accept the first alignment location

18. Click **OK** at the bottom right corner of the screen.

    The prompt at the bottom of the screen now says,

    Click the left mouse button to teach the second point

Figure 4.27 *KLA-Tencor Stylus Alignment Tool*



19. Use the left arrow button follow the dividing line to the right until it reaches the end of the line. (See *Figure 4.27*.)

20. Move the cursor directly over the line and click precisely on the line.

    The system adjusts the theta alignment so the Stylus alignment tool is lined up with the X- and Y-axis. The prompt at the bottom of the screen now says,

    Press OK to accept the second alignment location

END Align Sample Procedure

21. Click **OK** at the bottom right of the screen to accept the stage alignment of the Stylus Alignment Tool.

    The prompt at the bottom of the screen now says,

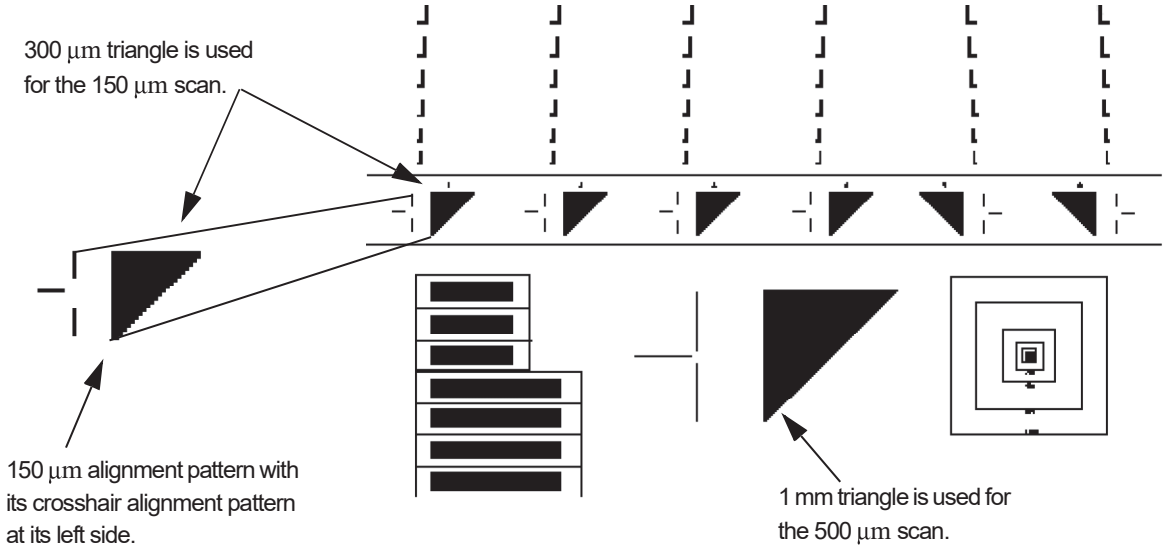
    Focus and align tool crosshairs with screen crosshairs

    There are two different alignment patterns that can be used in the Scan Position Offset Calibration. Each scan is conducted at the midpoint of the triangle where the step distance is one half the length of both right angle triangle sides. The first and primary alignment pattern is the 300 µm triangle which is called the 150 µm alignment pattern. It has this name because the scan traverses the triangle at it midpoint where the distance is 150 µm. The second is the 1000 µm (1 mm) triangle which is called the 500 µm alignment pattern because its midpoint scan distance is 500 µm. It is used when the 150 µm scan fails to locate the 300 µm triangle.

    When making this calibration, first use the 300 µm triangle to complete the 150 µm scan. If the stylus offset is too great, the scan misses the triangle. If this happens, try the 1000 µm (1 mm) triangle to complete the 500 µm scan. If that is successful, retry the 300 µm triangle.

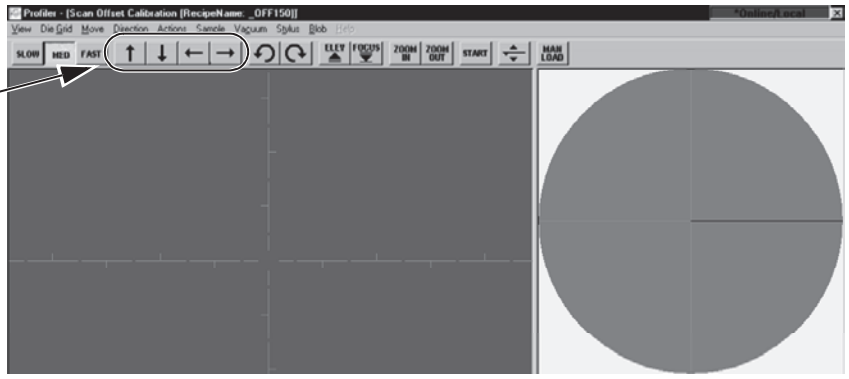
    If the 500 µm scan missed the 1000 µm triangle, the stylus needs to be physically realigned by an authorized KLA-Tencor service representative.

Figure 4.28 *KLA-Tencor Stylus Alignment Tool*



22. Use the linear movement arrow buttons (see *Figure 4.29*.) to locate one of the 150 µm alignment patterns with its crosshair alignment pattern at its left side. (See *Figure 4.28*.)

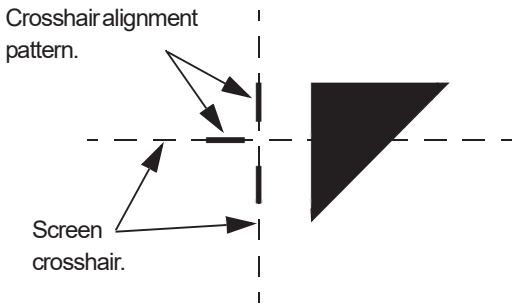
Figure 4.29 *Aligning the Tool with Screen Crosshair*



Step 22 Use the arrow buttons to locate one of the 300 µm triangles with its crosshair pattern next to it.

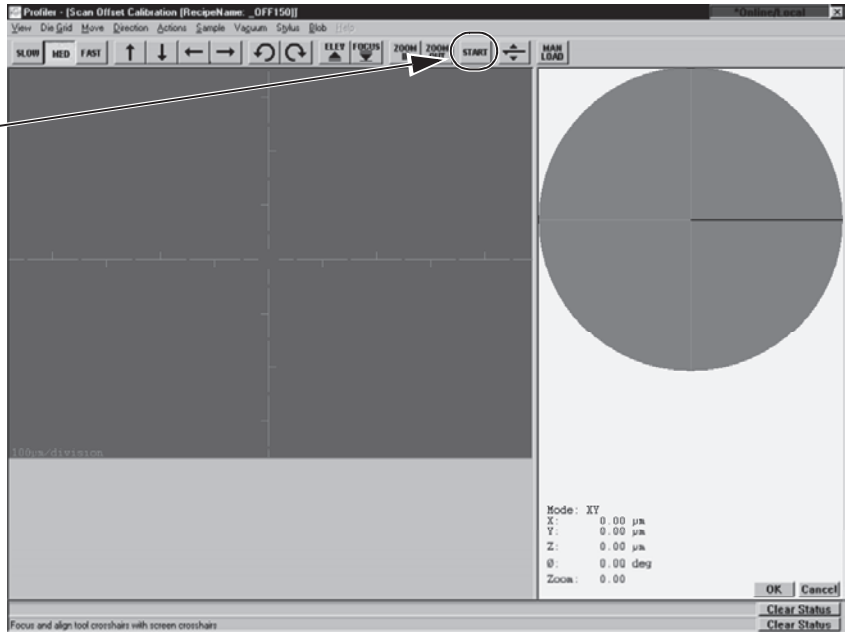
23. Click at the center of the Crosshair Pattern to align it with the screen crosshair. (See *Figure 4.30*.) The crosshair pattern should align precisely with the screen crosshair.

Figure 4.30 *Align Screen Crosshair with 150 µm Crosshair Pattern*



24. Click the **START** button located in the screen tool bar. (See *Figure 4.31*.)

Figure 4.31 *Manual Load from the Scan Offset Calibration Window*



The video image changes to side view as the stage moves to position the start of the scan on the beginning of the start pattern near the calibration triangle.

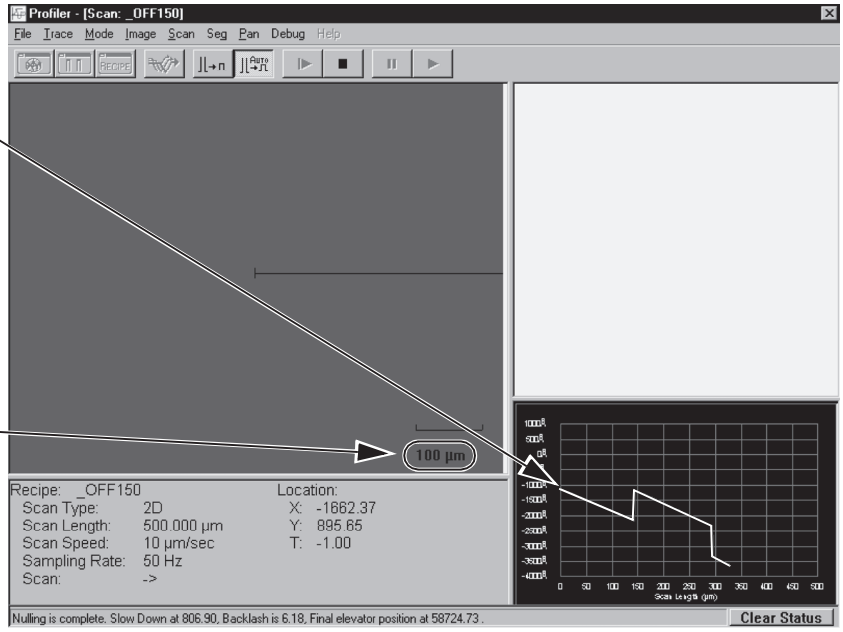
When the stylus has reached the beginning of the 150 µm scan trace, the screen changes to the **Scan: _OFF150** window. The scan automatically begins.

Figure 4.32 *Scan: _OFF150 Window*

As the scan proceeds, the trace line progresses from left to right across the scan trace.

As soon as the scan is complete, the scan screen is automatically replaced with the Analysis screen. See *Figure 4.34*.

Scan calibration mark.



The scan can be viewed at the bottom right of the **Scan: _OFF150** screen as it progresses from left to right across the scan trace window, forming a linear image of the scanned surface. The Start pattern next to triangle is set up to direct the scan through the middle of the triangle using the **_OFF150** recipe. In a perfectly calibrated system, the scan trace goes directly through the center of the 300 µm triangle creating a 150 µm trace step. However, this is not a common occurrence for a system that has not yet been calibrated after a stylus change.

The system uses the step and the distance across the triangle to determine where the trace was performed and then automatically calculates the offsets.

Figure 4.33 *Trace Path Through Upper Triangle*

The user is directed to set the scan to begin at the intersection of the three lines.

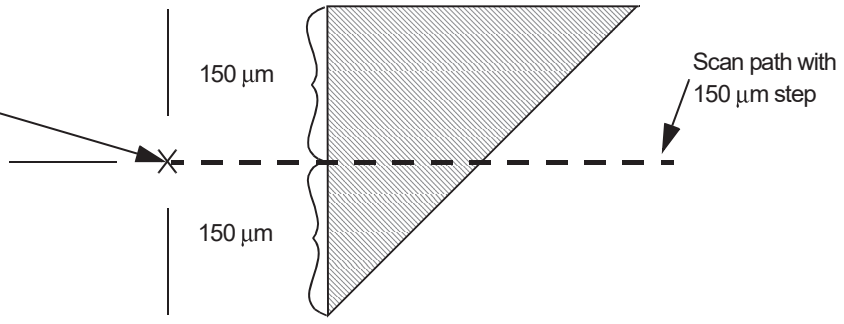
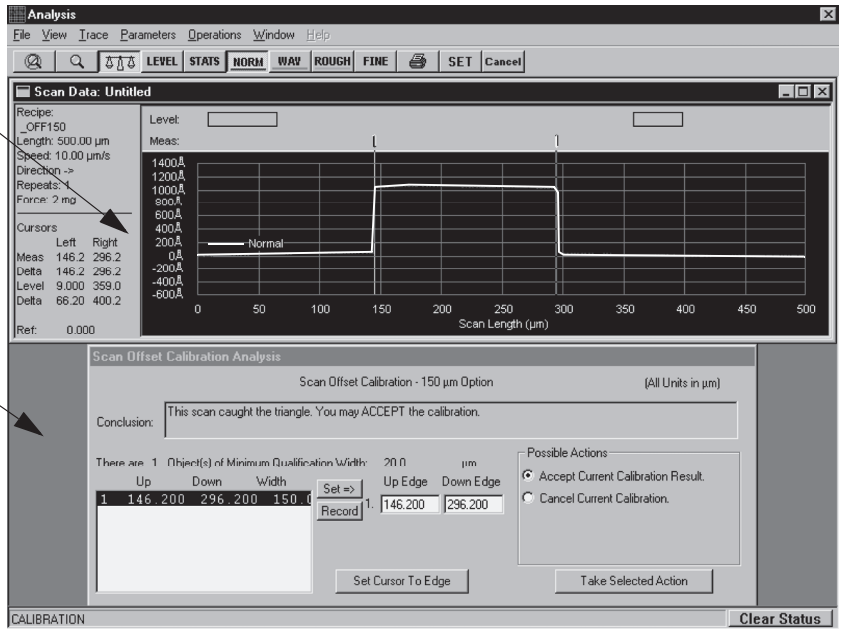


Figure 4.34 *Data Analysis Window.*

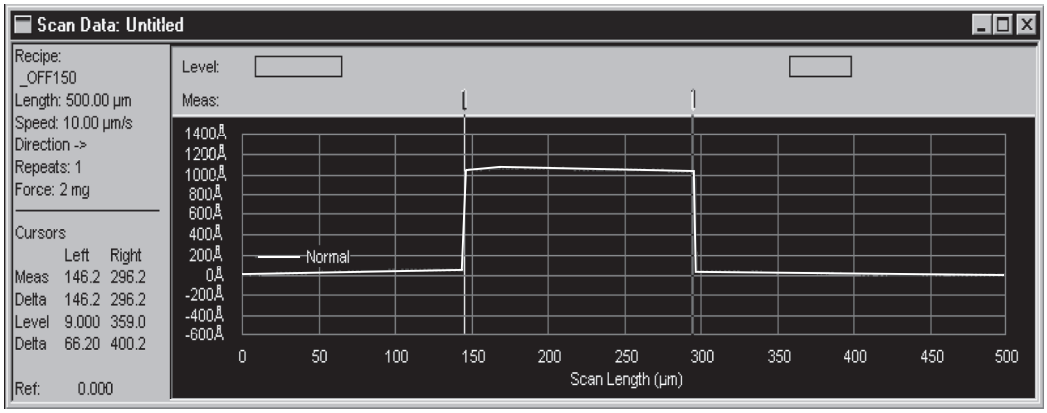
Scan trace display.
See *Figure 4.35*.

Scan data analysis.
See *Figure 4.36*.



When the scan is complete, the **Data Analysis** window automatically replaces the **Scan: _OFF150** screen. The window contains a scan data trace as shown in *Figure 4.35*. If the scan was successful, the system detected the triangle and set cursors at the edges of the triangle for visual inspection. It is possible to observe the scan and determine, visually, where the trace is running through the triangle.

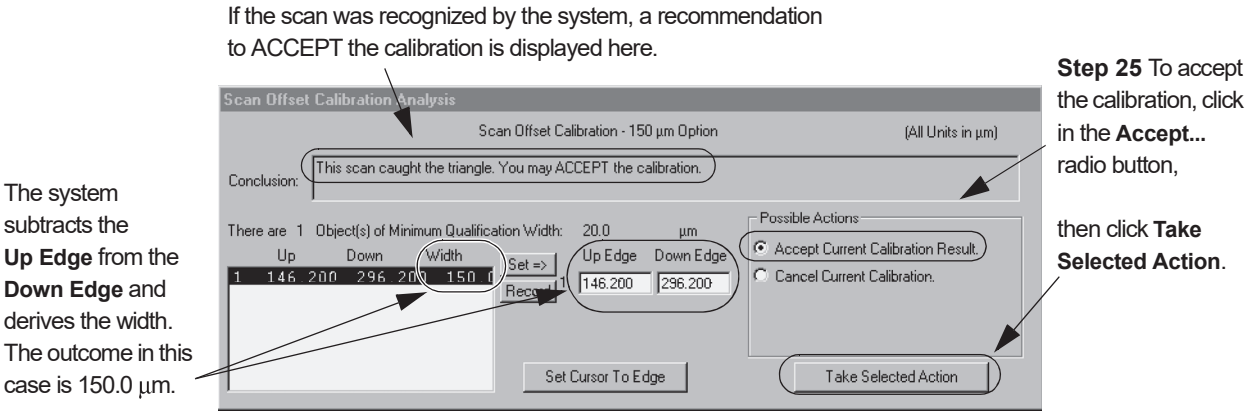
Figure 4.35 *Scan Data Portion of the Analysis Window*



In the bottom half of the window, the **Scan Offset Calibration Analysis** appears. In *Figure 4.36* the system has subtracted the Up Edge from the Down Edge and calculated the result to be 150.0 µm. Using this analysis of the scan, the system makes a recommendation based upon its recognition of the **Stylus Alignment Tool** triangle pattern.

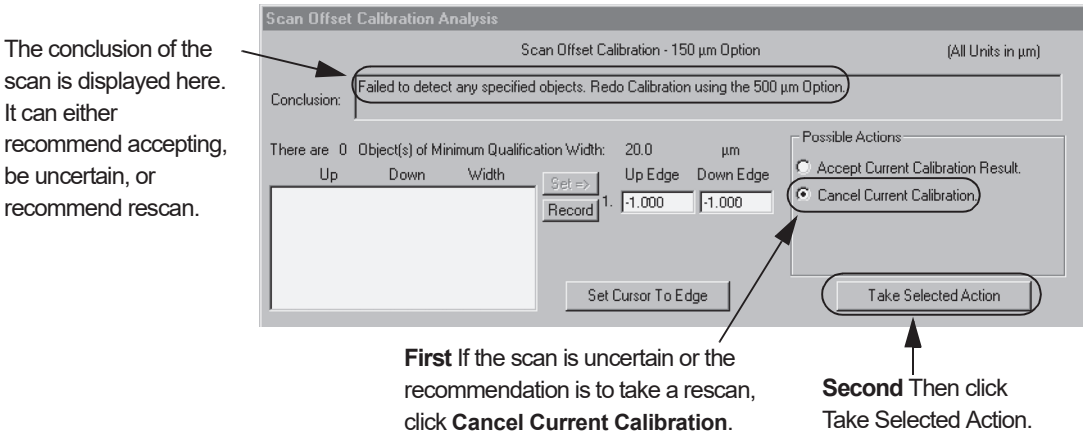
25. To accept the recommendation, ensure that **Accept Current Calibration Result** is chosen, then click on **Take Selected Action**. (See *Figure 4.36*.)

Figure 4.36 *Coarse Scan Data Analysis Window*



If the trace misses the triangle or is unable to identify it, one of several messages can be displayed. If the message reads, "Unknown situation…" or is otherwise uncertain, perform the entire scan procedure again, this time using the 1000 µm (1 mm) triangle and replacing the 150 µm scan recipe with the 500 µm scan recipe, _OFF500. If the 500 µm scan is acceptable, perform the 150 µm scan again. The results should be acceptable.

Figure 4.37 *"Unknown Situation" Corrective Action*

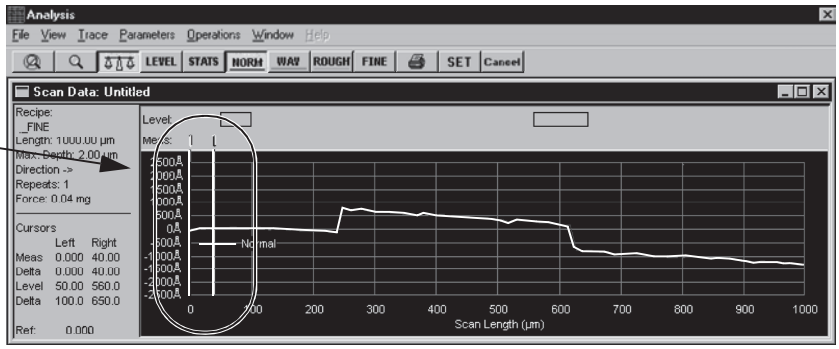


When the Triangle is Present, But System Does Not Find It.

The message could also say that the scan might have caught the triangle and ask the user to choose either to accept it, change the location, or reject it. If the **Conclusion** box informs the user that the system either didn't find the triangle for sure or asks the user to check the trace for the presence of the triangle, it might be necessary to reset the measurement cursors. (See *Figure 4.38*.)

Figure 4.38 *Pre Acceptance Analysis Screen*

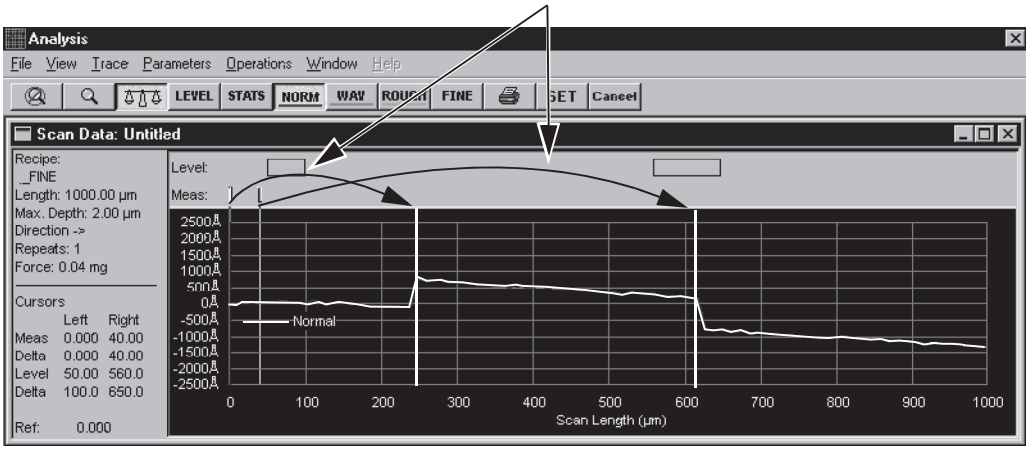
In this case, the system placed the identification cursors at the left edge of the trace, missing the triangle that is obviously displayed mid trace. (See *Figure 4.39* for resolution.)



1. If the triangle is obvious, reset the measurement cursors to the top edges of the triangle. To reset the measurement cursors, look in the top area over the graph, click and hold on the right cursor, then drag it to the top right corner of the step in the trace. Repeat for the left cursor, dropping it on the top left corner. (See *Figure 4.39*.)

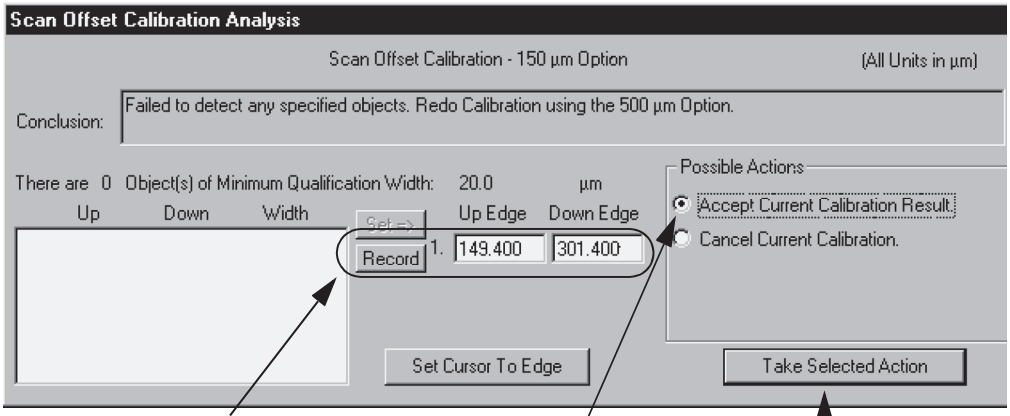
Figure 4.39 *Analysis Screen with Cursors Manually Placed*

Click, hold and drag each cursor to the top edges of the step.



2. Once the measurement cursors are in position, click **Record** in the Scan Offset Calibration Analysis section of the screen. (See *Figure 4.40*.)

Figure 4.40 *Scan Offset Calibration, Analysis Information Window*



Step 2 Once the cursors have been placed at the top edges of the triangle, click **Record** to set the coordinates of the triangle edges in the Up Edge and Down Edge fields.

Step 2 Choose **Accept Current Calibration Results** by clicking in its empty radio button.

Step 3 Click **Take Selected Action** to save the calibration results.

3. When the edges of the triangle have been recorded, choose **Accept Current Calibration Result** in the **Possible Actions box**. (See *Figure 4.40*.)
4. Click **Take Selected Action**. (See *Figure 4.40*.)

When More Than One Possibility is Displayed

On rare occasions the system fails to recognize the triangle even though it is in the data set. The system might also make a determination that one of a number of detected features is the correct one. To determine if the triangle is in a given data set, review the scan data set of detected features at the bottom left of the Scan Offset Calibration Analysis portion of the screen. If the triangle is present then the scan calibration can be reset.

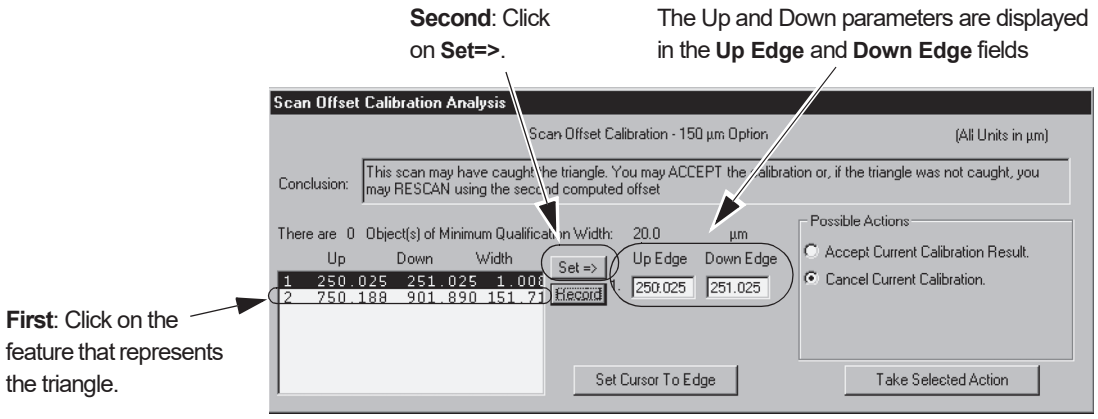
1. Click on the scan feature data set that represents the triangle so that it highlights.

   In *Figure 4.41* the system choose feature number 1 and set its parameters in the Up Edge and Down Edge fields. (See *Figure 4.41*.) However, feature number 2 is 151.71 µm which is very near the expected scan distance of 150 µm. In this example the user would click on that feature to highlight it.

2. With the feature highlighted, click on **Set** to choose that feature as the triangle.

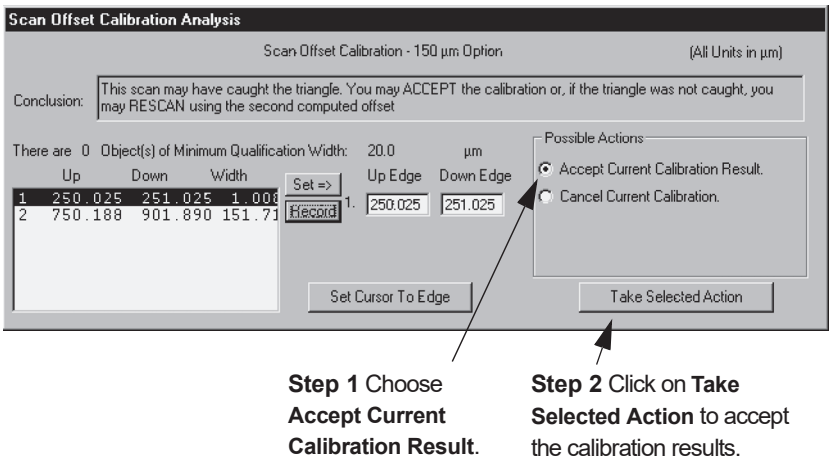
   The Up and Down parameters of the data set are recorded in the Up Edge and Down Edge fields. (See *Figure 4.41*.)

Figure 4.41 *Hand Selecting the Triangle Data in Analysis Screen*



1. Once the feature is chosen, choose **Accept Current Calibration Result**. (See *Figure 4.42*.)
2. Click **Take Selected Action**. (See *Figure 4.42*.)

Figure 4.42 *Accepting Adjusted Scan Results*



3. After the scan calibration has been accepted, the **Calibrations** screen returns. Close the Calibration screen.

5

XY VIEW SCREEN

INTRODUCTION

The name XY View comes from the function of the screen itself, which is for viewing the sample surface, and positioning a scan. The XY View screen also provides other tools required to set up and perform a scan.

The appearance of the video image depends on the zoom setting being used to view the sample surface and the current accuracy of the focus.

The P-15 has a zoom capability that allows the operator to zoom in and out to view the sample surface at different magnification levels.

This chapter describes:

STARTING THE XY VIEW APPLICATION

Procedure

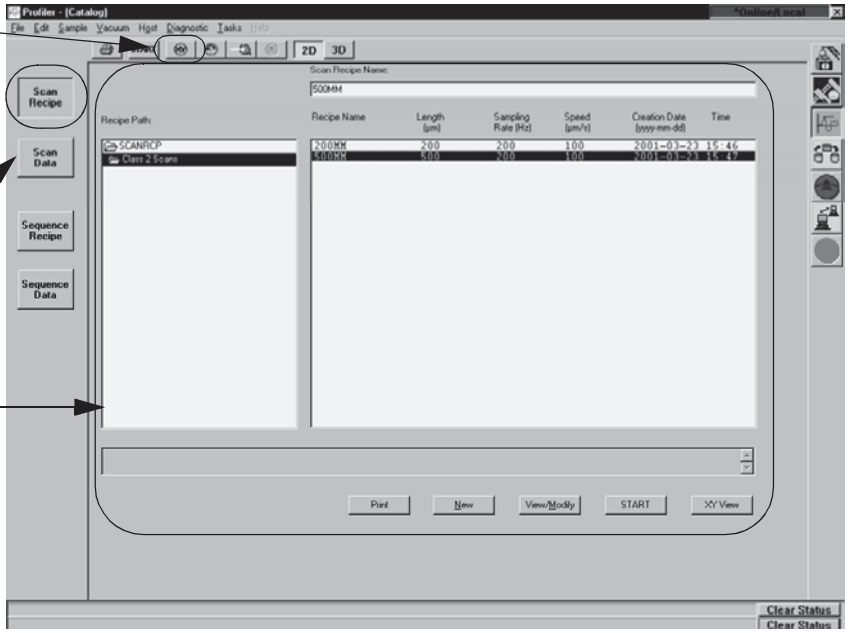
1. When the **Catalog** screen is first displayed, the **Sequence Recipe** list is in the Information Display window. To change to the **Scan Recipe** list, click on the **Scan Recipe** button. (See *Figure 5.1*.)

Figure 5.1 *Scan Recipe Window in the Catalog Screen*

Step 2 With a Scan Recipe highlighted, click on the **XY** icon to display the **XY View** screen.

Step 1 When the screen opens, click on the Scan Recipe button to display the Scan Recipe list in the Information Display window.

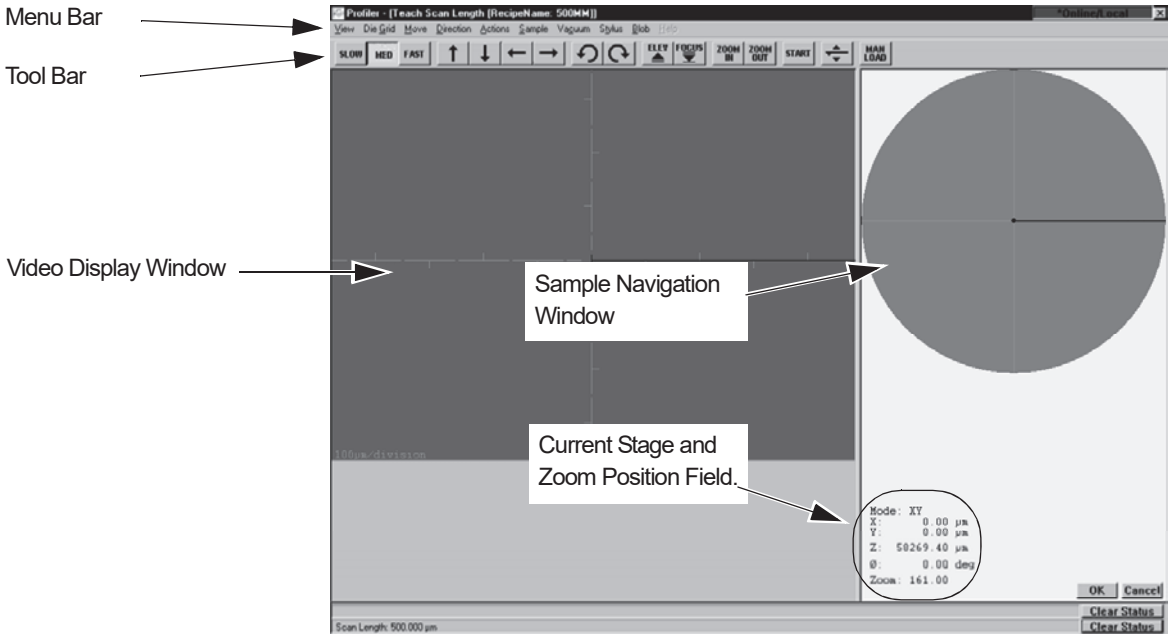
Information Display window



2. Once the Scan Recipe window is active, ensure that the desired scan recipe is highlighted by clicking on it. With the recipe highlighted, click the **XY** button to display the XY View screen. (See *Figure 5.1*.)

XY View Window Features

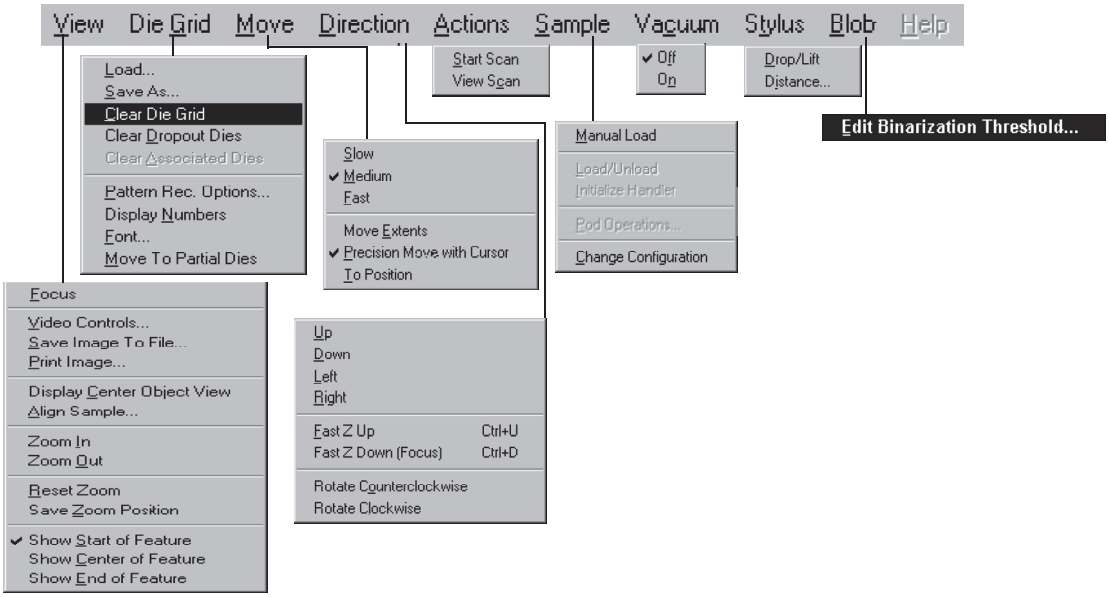
Figure 5.2 *XY View Screen*



XY View Menu Bar

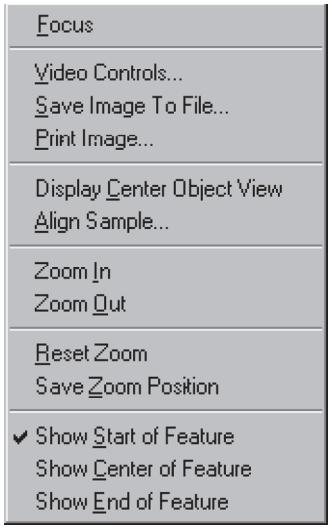
The Menu Bar contains the majority of the available screen function commands. Each function is explained in detail in this section.

Figure 5.3 *XY View Screen Menu Bar*



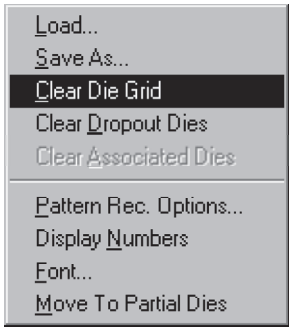
View Menu

Table 5.1 *View Menu Description*

View Menu	Description
	**Focus** Using the current magnification setting, this button causes the system to focus on the sample that is on the stage at the same time that the stylus is nulled on the sample surface.
	Video Controls… Displays the Video Display Dialog Box.
	Save Image to File… Displays the dialog box which set up the location of the file where the image is to be saved.
	Print Image… Displays the dialog box for printing the image in the video portion of the screen.
	Display Center Object View This puts the center of the object being scanned at the screen crosshair.
	Align Sample… Displays the dialog box used for setting up the angular rotation of the sample on the sample stage and initiates the automated procedure for aligning the sample to the video display.
	Zoom In Causes the optics to zoom in to a higher magnification.
	Zoom Out Causes the optics to zoom out to a lower magnification.
	Reset Zoom Resets the zoom position to "0" when the Zoom is active (position not saved).
	Save Zoom Position Displays a dialog box where the zoom position is set and locked so that it cannot be changed by the Zoom In and Zoom Out buttons.
	Show Start of Feature Displays, at the crosshair of the video display, the starting point of the scan.
	Show Center of Feature Displays, at the crosshair of the video display, the center of the scan on the sample surface.
	Show End of Feature Displays, at the crosshair of the video display, the end of the scan on the sample surface.

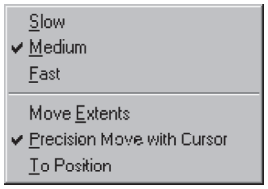
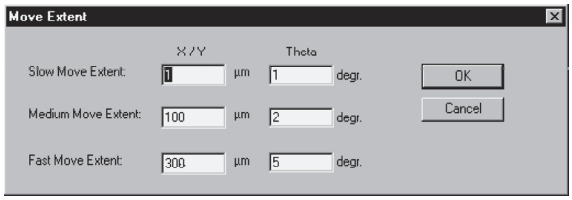
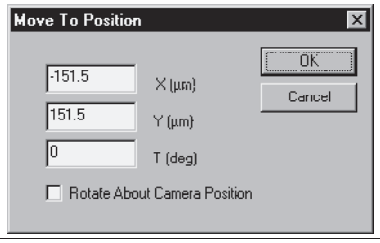
Die Grid Menu

Table 5.2 *Die Grid Menu*

Die Grid Menu	Description
	**Load…** Displays the dialog box used to load a die grid pattern.
	Save As… Saves the die grid pattern.
	Clear Die Grid Removes any die grid pattern on the video display window. [See *Clearing a Die Grid (Turn OFF Die Grid Navigation)* on page 5-30.]
	Clear Dropout Dies Blocks the dies from being scanned when a mouse cursor is placed over the die on the Sample Positioning Window and the **SHIFT+LEFT MOUSE BUTTON** is pressed.
	Clear Associated Dies Removes dies which were previously **associated** in a sequence recipe.
	Pattern Rec. Options… This displays the Load Die Grid dialog box. [See *Loading a Die Grid (Turning ON Die Grid Navigation) for a Single Scan* on page 5-28.]
	Display Numbers Displays the numbers on the Sample Positioning Window.
	Font… Displays the font dialog box used to change the screen fonts.
	Move To Partial Dies Scans the partial die at the edge of the wafer perimeter, only when this feature is enabled. Normally, these partial dies cannot be scanned because of the circular wafer edge, but this feature allows them to be scanned.

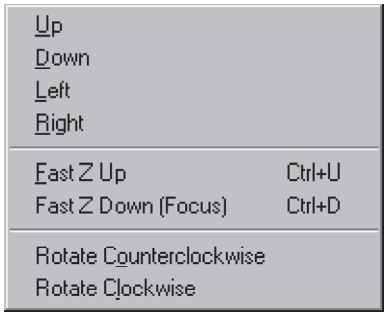
Move Menu

Table 5.3 *Move Menu*

Move Menu	Description
	**Slow** – Sets the XY stage to move in the slowest, or smallest increment, speed as defined in the **Move Extents**.
	Medium – Sets the XY stage to move in medium, or intermediate increment, speed as defined in the **Move Extents**.
	Fast – Set the XY stage to move in fast, or largest increment, speed as defined in the **Move Extents**.
	Move Extents – Sets the increment (Slow, Medium, Fast) for the stage movement. Enter the μm per click distance in each field for X/Y movement and the degrees in the Theta fields. ***Figure 5.4*** *Move Extents Dialog Box*  **EXAMPLE For the X and Y movement:** If **Fast** speed is selected (with the Fast value set to 300 microns), then the stage moves by 300 microns each time an arrow button is clicked. **EXAMPLE for Theta Rotation:** For the theta (rotational) movement. Sets the rotational increment (Slow, Medium, Fast) in degrees, for the stage movement with each button or key click. If **Fast** speed is selected (with **Fast** set to 5°), then with each click the stage rotates 5°.
	Precision Move – Takes out any backlash in the lead screws.
	To Position – This displays the **Move To Position** dialog box. Enter the coordinates the stage is to move to. If a rotational move is used to reorient a feature already in view so it can be scanned in a different direction, also choose **Rotate About Camera Position**. Click **OK** to make the move. ***Figure 5.5*** *Move To Position Dialog Box* 

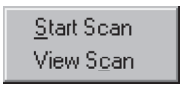
Direction Menu

Table 5.4 *Direction Menu*

Direction Menu	Description
	**Up** – Moves the stage in the +Y direction away from the front door by one increment (as defined in **Move Speeds** for the set speed) per button click. Click and hold the button for continuous movement.
	Down – Moves the stage in the -Y direction toward the front door by one increment (as defined in **Move Speeds** for the set speed) per button click. Click and hold the button for continuous movement.
	Left – Moves the stage in the -X direction toward the left by one increment (as defined in **Move Speeds** for the set speed) per button click. Click and hold the button for continuous movement.
	Right – Moves the stage in the +X direction toward the right by one increment (as defined in **Move Speeds** for the set speed) per button click. Click and hold the button for continuous movement.
	Fast Z Up – Raises the measurement head away from the stage by one increment per button click. Click and hold the button for continuous movement. This is the same as clicking the **Elev** button.
	Fast Z Down (Focus) – Lowers the measurement head and sensor to the null position, and focuses the video image. The measurement head automatically lowers to the correct distance from the sample for real-time video. This is the same as clicking the **Focus** button.
	Rotate Counterclockwise – Rotates the stage in the theta counterclockwise direction by one increment (as defined in **Move Speeds** for the set speed) per button click. Click and hold the button for continuous movement.
	Rotate Clockwise – Rotates the stage in the theta clockwise direction by one increment per button click. Click and hold the button for continuous movement.

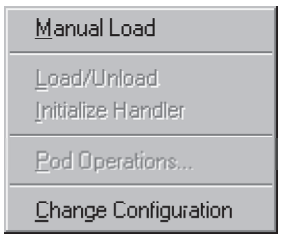
Actions Menu

Table 5.5 *Actions Menu*

Actions Menu	Description
	**Start Scan** Starts the scan process.
	View Scan Changes to the View Scan window.

Sample Menu

Table 5.6 *Sample Menu*

Sample Menu	Description
	**Manual Load** Moves the stage towards the front door. This is used for loading wafers.
	Load/Unload Not applicable for the P-15 system.
	Initialize Handler Not applicable for the P-15 system.
	Pod Operations… Not applicable for the P-15 system.
	Change Configuration This brings up the **Safe Area** configuration box.

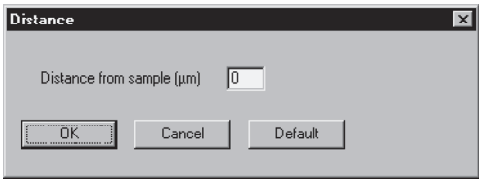
Vacuum Menu

Table 5.7 *Vacuum Menu*

Vacuum Menu	Description
	**Off** Not applicable for P-15 systems. The vacuum status is set using a manual switch next to the door.
	On Not applicable for P-15 systems. The vacuum status is set using a manual switch next to the door.

Stylus Menu

Table 5.8 *Stylus Menu*

Stylus Menu	Description
	**Drop/Lift** Causes the stylus to pivot up. A check mark is visible while it is in the UP position. Click on it to release it back to its normal scanning position
	Distance… Displays the **Distance From Sample** dialog box. This is the distance from the stylus to the sample surface during scan positioning. Set the number in μm and click **OK**. The distance remains in effect until changed by the user. ***Figure 5.6*** *Distance Dialog Box* 

Blob Menu

Table 5.9 *Blob Menu*

Blob Menu	Description
	**Edit Binarization Threshold** Activates the Blob Analysis capability when the **Display Center Object View** feature is selected from the **View** menu. This allows the user to draw a box around an object visible in the video image, and the stage moves to the center of that object using the image contrast to locate the object. The contrast value can be set from 0 to 255 with a typical range of 60 to 100. **EXAMPLE**: if selecting a dark object, set the threshold to a high value so that greater contrast is used to help distinguish the object from the surrounding area. [See *Using Blob Analysis (Center Object Search)* on page 5-32.]

Tool Bar Buttons

Table 5.10 *XY View window Tool Bar Buttons*

Button	Description
	Sets the XY stage to move in small increments as set in **Move Extents**.
	Sets the XY stage to move in moderate increments as set in **Move Extents**.
	Sets the XY stage to move in large increments as set in **Move Extents**.
	Moves the stage in the +Y direction (away from the front door) by one increment (as set in **Move Extents**) per button click. Click and hold the button for continuous movement.
	Moves the stage in the -Y direction (toward the front door) by one increment (as set in **Move Extents**) per button click. Click and hold the button for continuous movement.
	Moves the stage in the -X direction (toward the left) by one increment (as set in **Move Extents**) per button click. Click and hold the button for continuous movement.
	Moves the stage in the +X direction (toward the right) by one increment (as set in **Move Extents**) per button click. Click and hold the button for continuous movement.
	Rotates the stage in the theta counterclockwise direction by one increment (as set in **Move Extents**) per button click. Click and hold the button for continuous movement.
	Rotates the stage in the theta clockwise direction by one increment (as set in **Move Extents**) per button click. Click and hold the button for continuous movement.
	Raises the measurement head away from the stage by one increment per button click. Click and hold the button for continuous movement.
	Lowers the measurement head containing the sensor assembly to the null position, with the stylus just above the surface, and focuses the video image.
	Changes to a higher magnification with each click.
	Changes to a lower magnification with each click.
	Starts the scan process.

Table 5.10 XY View window Tool Bar Buttons (Continued)

Button	Description
	A toggle that lifts and drops the stylus.
	Toggle button that moves the stage to and away from the Manual Load position. Before each movement, the measurement head moves to the set Z-height to protect the sensor assembly from accidental contact.

SETTING THE MAGNIFICATION

Introduction

The system has an optical zoom function that allows the operator to view the sample surface at different magnifications for feature identification and scan placement.

If the system has Pattern Recognition operating, zooming in and out could prevent the system from performing accurately because the recognition function also takes into consideration the size of the image as well as its shape.

Changing the Magnification

Click the **ZOOM IN** or **ZOOM OUT** to change the magnification. Each click changes the magnification level in or out by a small amount.

> (Alternative:
> In the Menu bar click on **View** to display its menu. From the **View** menu, select either **Zoom In** or **Zoom Out** to change the magnification. Each click changes the magnification level in or out by an amount a little more than twice the size of the button icons.)

For systems using the Pattern Recognition option, the zoom function can greatly effect those system's ability to perform the recognition function. If the Zoom position is set and left at a particular zoom level, the system is dependable using the Pattern Recognition option.

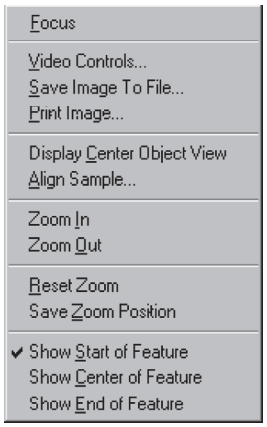
Resetting the Zoom to "0.00"

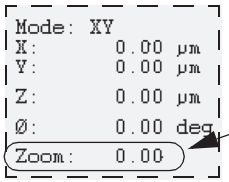
If the zoom function has been used, it might be necessary to use the **Reset Zoom** to return the zoom magnification to exactly "**0.00**" in the Zoom field at the bottom right of the screen.

Click on **Reset Zoom** and the system automatically zooms out to the furthest position and sets the Zoom field to **0.00**.

Figure 5.7 *View Menu and the Stage and Zoom Coordinate Field*

Click **Reset Zoom** from the View menu to reset the **Zoom** to exactly **0.00**.





In the **Zoom** field, the current zoom position is displayed. This is not the magnification.

Saving the Current Zoom Position

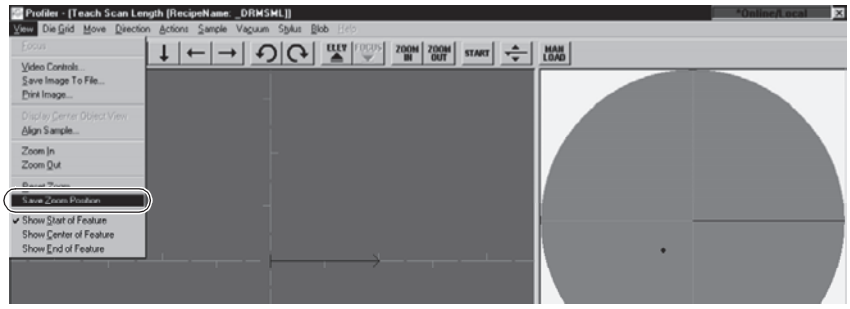
For systems operating with the Pattern Recognition option, it is extremely important that the Zoom position be ***locked*** so the system can perform the pattern recognition function properly. Saving the current zoom position is also called "zoom lock." This function relies on both shape and size for the recognition process to be effective. The most reliable way to secure the zoom position is to use the **Save Zoom Position** dialog box to set and lock the desired position.

Another reliable way is to leave the zoom feature at 0.00, then pattern recognition should work well. In this case, it is very important that, before the pattern recognition process is used, the operator remember to reset the zoom to 0.00.

1. Check to ensure that the current Zoom position, displayed in the Zoom field at the bottom left of the screen, is the position that the zoomed magnification is to be frozen at. If so, proceed to the next step. If not, adjust the zoom (magnification) to the required level using the zoom icons or menu items.
2. To save the current zoom position, click on **Save Zoom Position** in the **View** menu. This opens the Save Zoom Position dialog box. (See *Figure 5.8*.)

Figure 5.8 *View Menu in XY Vies Screen*

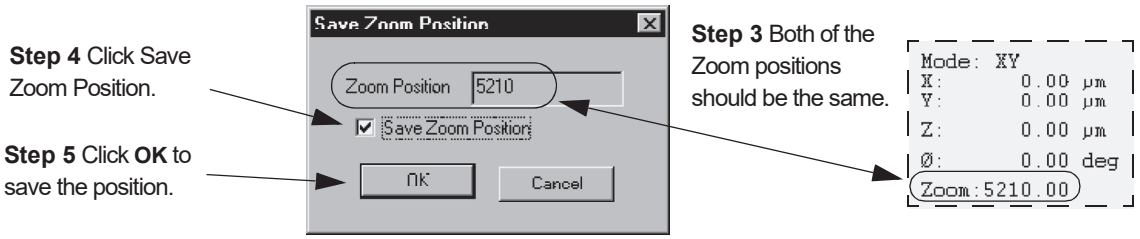
Step 2 Click **Save Zoom Position** to open its dialog box.



The Save Zoom Position dialog opens with the current zoom position in the Zoom field.

3. Ensure that the zoom position in the dialog box **Zoom** field agrees with the **Zoom Position** in the screen display. (See *Figure 5.9*.)
4. Put a check in the **Save Zoom Position** check box. (See *Figure 5.9*.)

Figure 5.9 *Save Zoom Position Dialog Box*



5. Click **OK** to save the position and disable the zoom icons in the tool bar and the zoom menu items in the View menu. (See *Figure 5.9*.)

FOCUSING THE VIEW

Introduction

Focusing on the sample surface is controlled by a combination of the nulling process and the system focus knobs.

Nulling

Fast Approach

In the first phase of the nulling descent, the measurement head lowers the stylus at a higher speed until it reaches a preset level above the sample surface. The default level set in the registry is 1000 µm above the Lowest Elevator Position. If the stylus touches the surface during the fast approach phase of the descent, an error is generated. The error is not speed dependant.

If the proximity sensor and the proximity sensor offset is used during the descent, the stage moves to position the proximity sensor over the same location at which the stylus eventually touches the surface.

If the proximity sensor is enabled, the Fast Approach ends when either the proximity sensor indicates the approaching surface. If the proximity sensor is disabled, the Fast Approach ends when the head reaches 1000 µm above the Lowest Elevator Position. The descent slows at this point and, if the Proximity Sensor Offset is applied, the system moves the stylus back over the contact point on the sample surface.

Slow Approach

This is the phase of the nulling descent in which the stylus contacts the sample surface. Even though this phase is called the Slow Approach, it is possible for the descent speed to be set to the same rate as the Fast Approach.

The Slow Approach ends when the stylus hits a surface and the stylus is pushed up above the horizontal position.

Final Adjustment

During the last phase of the nulling operation, the head moves upward very slowly until the stylus drops just barely below the horizontal position and slightly above the surface.

Focus

After the final adjustment to the head and stylus position, the system focusses on the surface.

After the null and focus procedure, if the sample surface is not in focus, the focus knobs can be used to bring the surface into focus. (This should only be required after stylus change.)

The purpose of focusing the view is to sharpen the image in the video window. If the focus is clear the first time, and the sample is flat, focus should be maintained each time the stage moves to another location on the same sample surface.

Proximity Sensor

The proximity sensor can be used in the transition between the Fast Approach and Slow Approach phases of the nulling procedure. The following restrictions apply to proximity sensor use:

- The proximity sensor works on optical principles and is therefore not for use with transparent surfaces. For transparent surfaces teach the Lowest Elevator Position and turn the proximity sensor off.
- The system accommodates the physical offset between the stylus and the proximity sensor by adjusting the stage position at the appropriated time before the scan procedure. The accommodation cannot be performed for measurements 15 mm or closer to the right hand side of the chuck. If measurements are to be taken at X-coordinate values that might fall within that restricted range, the Proximity Sensor Offset must be disabled. The proximity sensor can still be used, provided the sample is flat and not transparent.
- For small samples that are not transparent, the proximity sensor can be used in the nulling procedure provided that the offset has been correctly taught. The original offset was taught at the factory and should not be changed unless there is very good reason. Using the proximity sensor is especially convenient for sample with widely varying thickness between measurements, to avoid focussing errors, and to avoid repeated teaching of the Lowest Elevator Position.
- For samples having the same thickness (i.e., within ± 200 mm), disable the proximity sensor and rely on the Lowest Elevator Position. Since these samples have the same thickness, the Lowest Elevator Position does not need to be reset.

Focus the Optics – Top- or Side-View

1. Raise the measurement head.

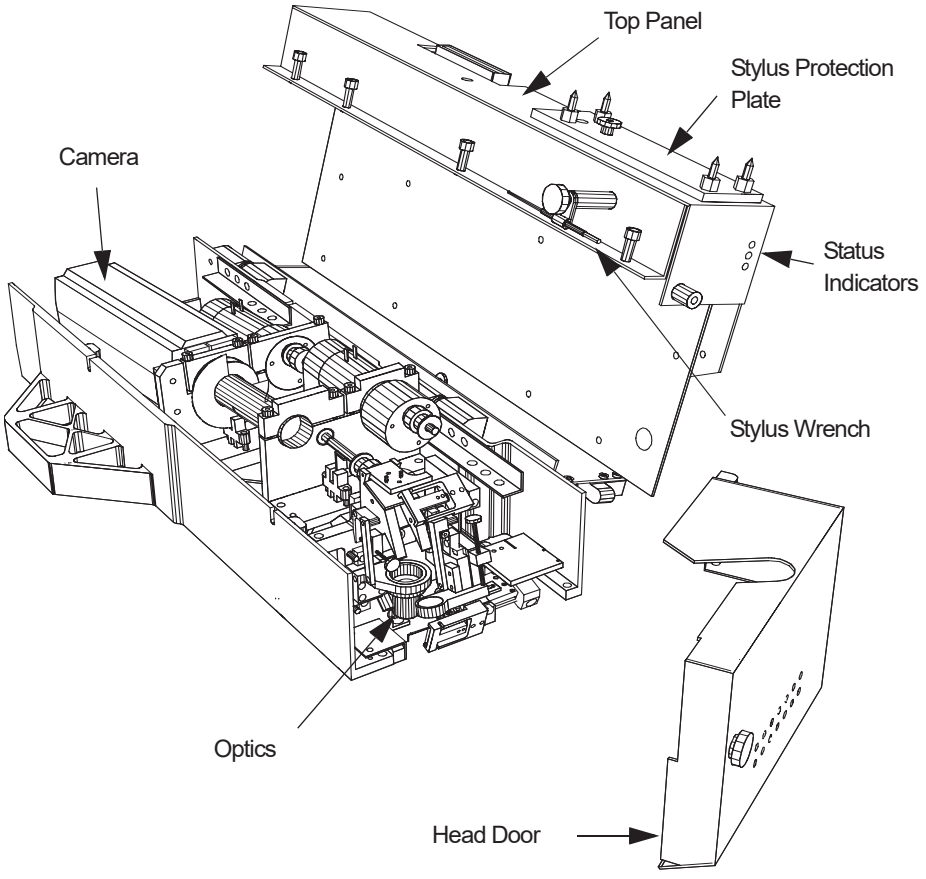
CAUTION: Before lowering the head, be sure that the sample is under the center of the optics, that the stage is not significantly out of level, and that there are no physical obstacles.

2. Use the **Focus** button to null the stylus on the sample (use a patterned sample with easily defined features).

NOTE: If the Proximity Sensor is not enabled, the elevator is designed to slow its rate of descent to 10 μm/sec when it reaches 1000 μm above the **Lowest Elevator Position**.

3. Open the measurement chamber door and then the head door. (See *Figure 5.10*.)

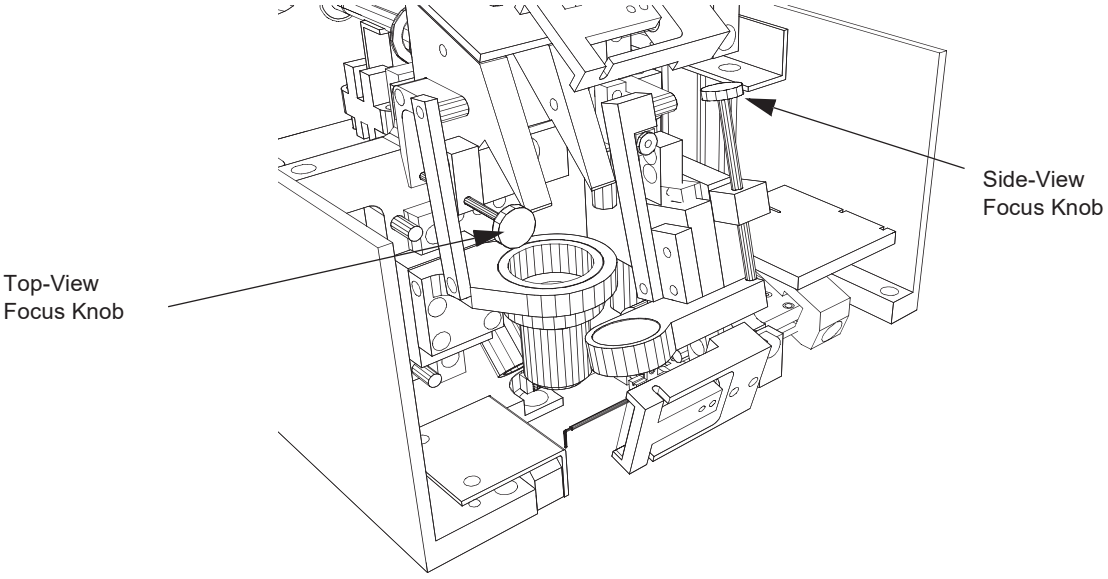
Figure 5.10 *MicroHead Measurement Head.*



4. If the initial view requires focusing, turn the **Top-View Focus** knob to focus the top view. (See *Figure 5.11*)
5. Click the **Stylus Drop-Lift** icon to lower the stylus onto the sample surface.

6. If the side view requires focusing, use the **Side-View Focus** knob to focus the side view. (See *Figure 5.11*)

Figure 5.11 *Focusing the Optics (Dual-View Optics).*



7. Test the Video Calibration after any mechanical refocusing event by clicking on a clearly definable feature and see if it lines up exactly with the screen crosshair. If not, perform the Video Calibration.

POSITIONING THE SCAN SITE

Introduction

The stage can be moved in the X, Y, and theta direction to orient an object image for scan positioning. The stage can be moved to reach any point on the sample surface within the Safe Area limits. (See *Safe Area Configuration* on page 11-21)

The stage moves incrementally in the following directions:

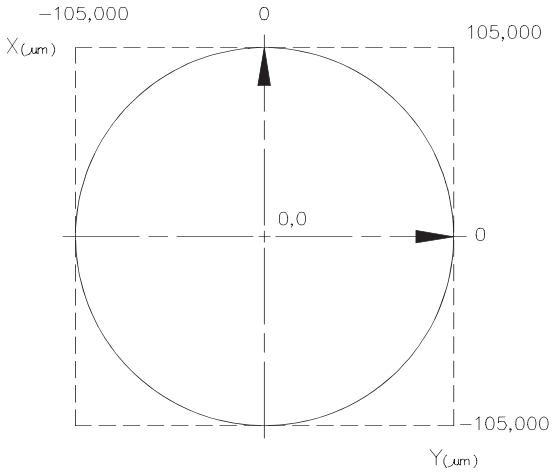
- The X direction moves the stage left and right
- The Y direction moves the stage forward and backward
- The theta direction rotates the stage clockwise and counterclockwise.

A common way to move the stage is to click on the arrow button that points in the direction that the stage is to move. Notice that the arrow points in the direction the stage moves and not in the direction that the image moves in the field of view.

NOTE: When using the toolbar arrow buttons, the image appears to wiggle as it stops. This is a normal part of the procedure designed to eliminate the slight mechanical backlash in the stage movement that could make precise positioning difficult.

Figure 5.12 shows the stage coordinate system (SEMI Standard M20-92) used by the Profiler. The X and Y coordinates relative to the center of the measurement area are displayed in the current stage coordinate area of the XY View window. The travel area of the stage is limited to a circle 210 mm (8.2 in.) in diameter. (See *Figure 5.12*).

Figure 5.12 *Coordinate System of the KLA-Tencor Profiler Stage*



Scan Site Positioning Procedure

1. After the sample is loaded on the stage and the stage returned to the scan position under the stylus, click **FOCUS**.
2. Use one or more of the following methods to locate a scan site. (See *Table 5.11*.)

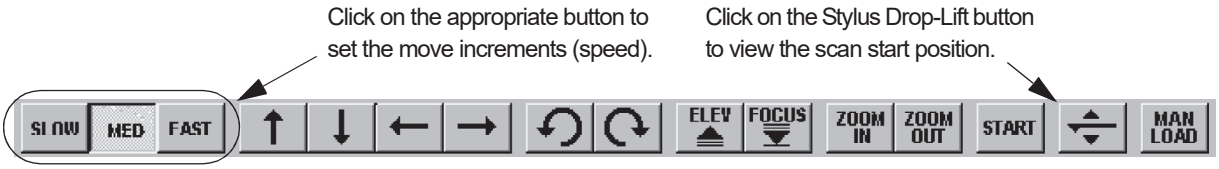
Table 5.11 *Locating a Scan Site*

Movement Required	Movement Method
To make a large move across the sample surface, use the **Sample Navigation Window** (See *Figure 5.14*.)	**Sample Navigation Window** – The navigation circle represents the stage area. Click the location on the Sample Navigation Window to move to the corresponding location on the sample. (See *Figure 5.14*.)
Move to a different site in the current **Video Display Window** (See *Figure 5.14*.)	**Video Display Window** – Click the desired site in video display window. (See *Figure 5.14*.) The site moves so that the video crosshair are centered on the chosen location.

Table 5.11 *Locating a Scan Site*

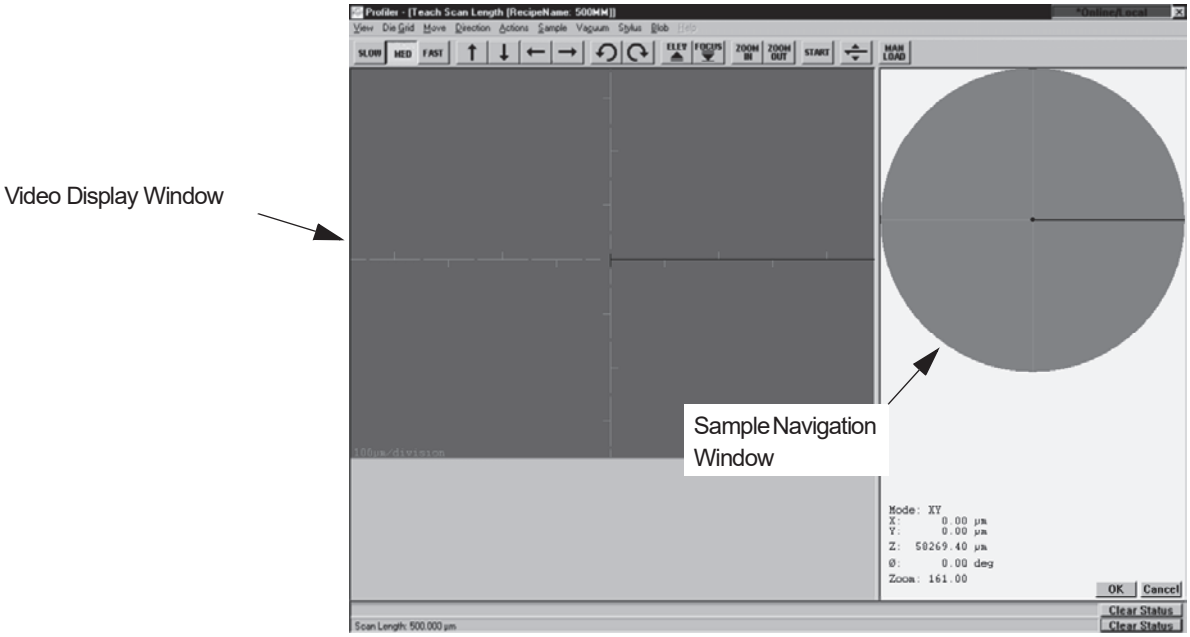
Movement Required	Movement Method
Move in increments across the sample using the **Video Display Window** to locate a feature or scan site.	**Arrow Buttons Positioning** – Click the **Fast**, **Medium**, or **Slow** buttons (move extents) to change the stage movement increments. (See *Figure 5.13*.) With the cursor over the arrow button, click for one move of the distance defined by the move extents setting. Click and hold to start and continue the stage movement in increments defined by the move extents. Release to stop the stage movement. **NOTE:** The incremental distance represented by the **Fast**, **Medium**, and **Slow** buttons can be changed by choosing **Move Extents** from the **Move** menu. The **Move Extent** dialog box appears in which the new speeds for each button can be entered.
Precision positioning using the Stylus Drop-Lift	**Stylus Drop-Lift Positioning** – After the null is complete, click the **Stylus Drop-Lift** button. This changes the optics to side-view with the stylus in the down position. Click on the scan site beginning point. Repeat if necessary until the stylus is at the desired starting point of the scan.

Figure 5.13 *XY View Screen Tool Bar*



3. Click the **Stylus Drop-Lift** button to null the stylus on the sample and confirm the scan position.

Figure 5.14 *XY View Screen*



USING DIE GRID NAVIGATION

Introduction

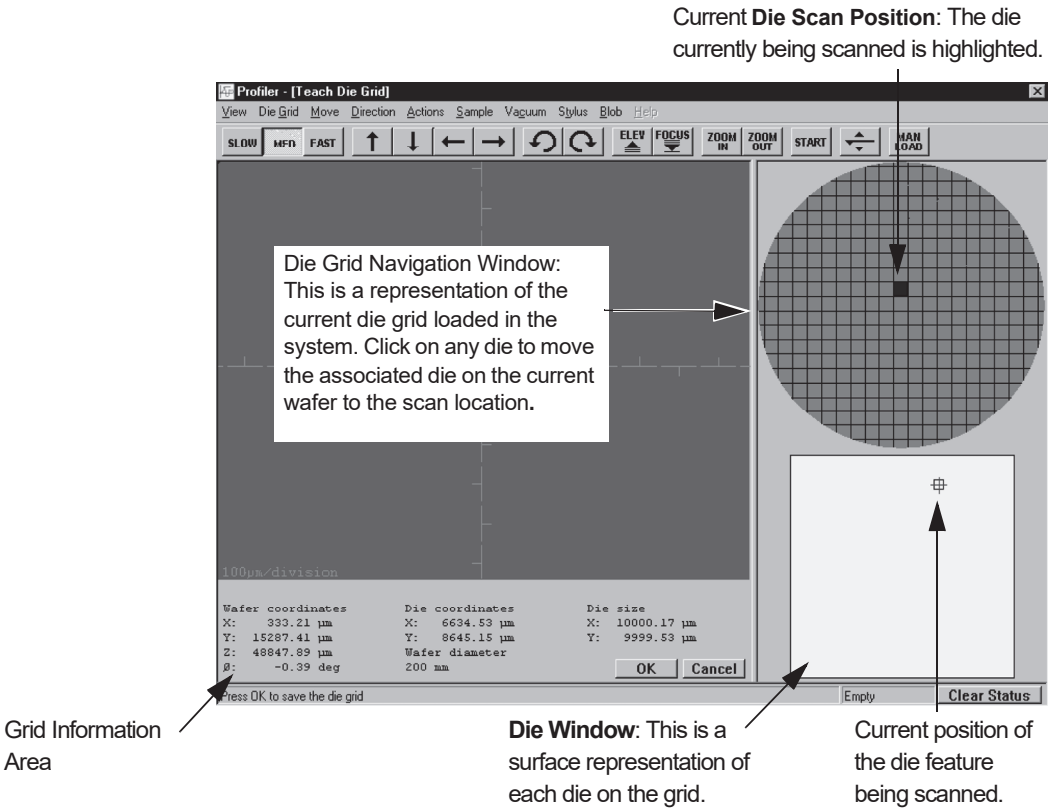
When scanning a wafer, the ***die grid navigation features*** can be used to teach scan and sequence sites by die location rather than by stage coordinates.

Die grid navigation is composed of two components: Die Grid Navigation Window; and Die Window.

The Die Grid Navigation Window presents a representation of the die positions on the wafer surface. (See the Die Grid Navigation Window in *Figure 5.15*.) The small highlighted rectangle, in the upper right quadrant of the die matrix, represents the die currently being scanned. Each time a new die is chosen, the scan is performed on the same position in that die. (See Die Window in *Figure 5.15*.)

The Die Window is designed to pinpoint the location of the feature to be scanned on each die. (See the Die Window in *Figure 5.15*.) The cursor in the rectangle represents the location on the die where the feature to be scanned resides. To move to another scan position in the die, click on the new position in the Die Window box.

Figure 5.15 *Teach Die Grid Screen with Loaded Die Grid*



Once a die grid pattern is loaded, the Die Grid Navigation Window appears in the Teach Scan screen (except in calibration procedures), Teach Sequence Site screen, and Teach Blob Analysis screen.

Die Grid windows (see *Figure 5.15*) differ from standard Teach windows in three aspects:

- **Die Grid Navigation Window**—replaces the Sample Navigation Window. (See *Figure 5.2*.) Click in the desired die grid to quickly move the corresponding die into the field of view in the Video Display Window.
- **Die Window**—for positioning a feature in the field of vision within the die itself. Click in the desired region to quickly move that area of the die into the field of view.
- **Grid information area**—contains wafer and current die coordinates, wafer diameter, and die size.

In making it more convenient to position scans on a wafer, Die Grid Navigation provides the following options:

- Mask out the dies that are not to be measured. Masked dies appear blacked out on the Die Grid Navigation Window, providing visual reference points.
- Display the die coordinates on the Die Grid Navigation window and even change the font and size of the numbers.
- Show the partial dies on the edge of the wafer.

Creating a Die Grid

Introduction

To use a die grid, one must be created using a sample with clearly defined identical dies, equally spaced. Once created, it can be used whenever measurements are being made on samples which are identical to the one used to make the die grid. Numerous die grids can be created, stored, and loaded as they are needed.

Wafer alignment on the sample stage is critical to the systems ability to consistently locate dies on the wafer. It must be precisely placed with it X- Y- orientation identical to that of the die grid. This can be accomplished by using a precision locator on the sample stage. The loaded die grid pattern is accurate only as long as the wafer is not moved after the initial die grid alignment procedure. This means that the vacuum must be turned on when the wafer is loaded and not turned off until the wafer is unloaded. If the wafer is moved, the die grid must be reloaded, a procedure which realigns the wafer dies with the die grid.

The die grid is created by establishing its size and position on a wafer, and identifying a unique and distinguishable feature which the system can use to locate the same position on any die.

Teach a Die Grid

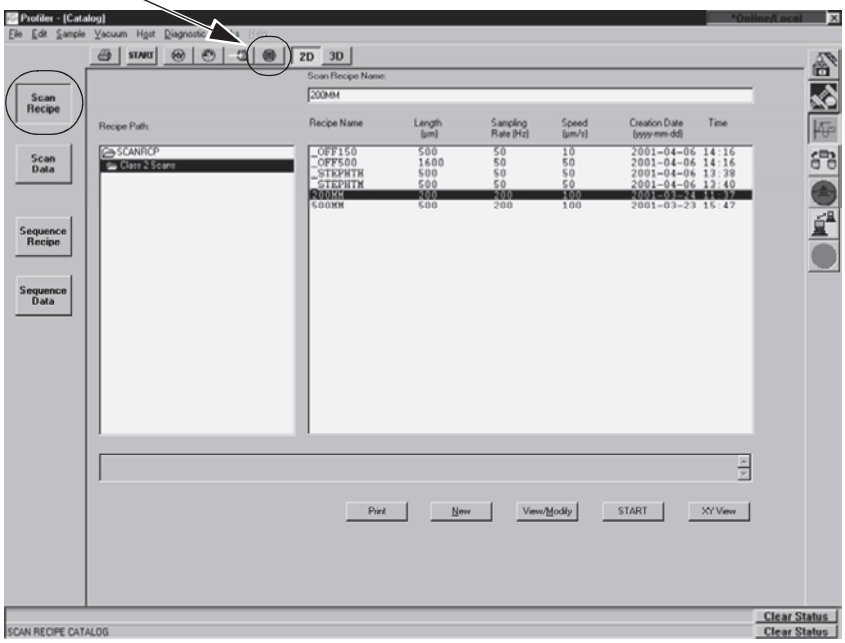
Creating a die grid is a user friendly procedure. Once the Teach Die Grid procedure is initiated, each step is prompted by a message at the bottom of the screen or next to the graphic.

1. Click on the **Scan Recipe** button at the top of the option list located at the left of the Catalog screen. (See *Figure 5.16*.)

Figure 5.16 *Scan Catalog Screen*

Step 2 Click on the Die Grid icon to initiate the **Teach Die Grid** procedure.

Step 1 Click on the **Scan Recipe** button to open the list of available scan recipes.

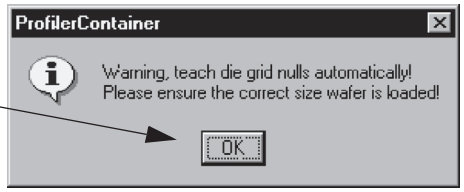


2. Click on the **Die Grid** button  in the tool bar, or select **Teach Die Grid** from the **File** menu. (See *Figure 5.16*.)

   The **Teach Die Grid** window appears with a warning about the automatic null feature of the Teach Die Grid procedure. (See *Figure 5.17*.)

Figure 5.17 *Warning – Automatic Null*

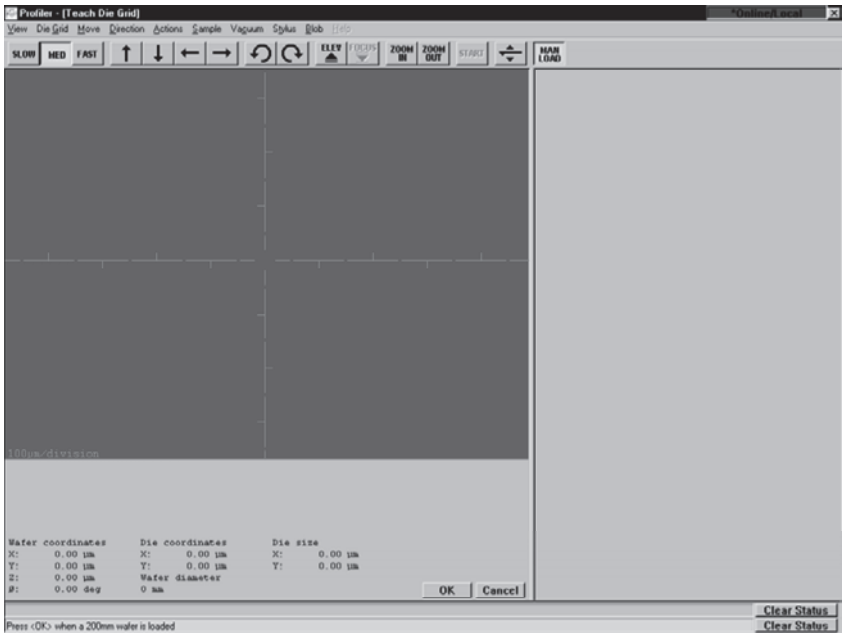
Step 3 Click **OK** to continue.



3. Click **OK** to continue with the procedure. (See *Figure 5.17*.)

4. In the **Teach Die Grid** screen, the procedure is prompted from the message display area at the bottom left of the screen. (See *Figure 5.18*.)

Figure 5.18 *Teach Die Grid Screen*



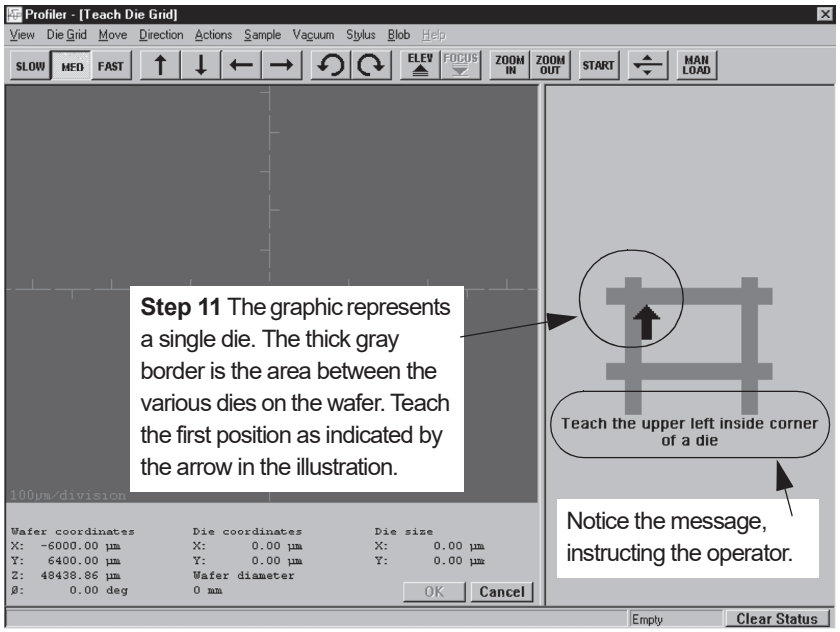
Step 4 The message prompt, here under the graphic, informs the operator of procedures as they occur and operator requirements.

Notice in *Figure 5.18* that the message prompt tells the operator to place a specific sized wafer on the stage and then click on **OK**. The system is configured to run a specific sized wafer. It is important that only that size wafer be used.

5. Obtain the wafer to be used in the teach die grid procedure
6. Click **MAN LOAD** to move the stage to the door.
7. Open the door and load the wafer onto the precision locator. (If there is no precision locator, have one installed before continuing with this procedure.)
8. Turn **ON** the vacuum using the switch located at the left inside edge of the door.
9. Close the door and click **MAN LOAD** to send the stage back under the measurement head.

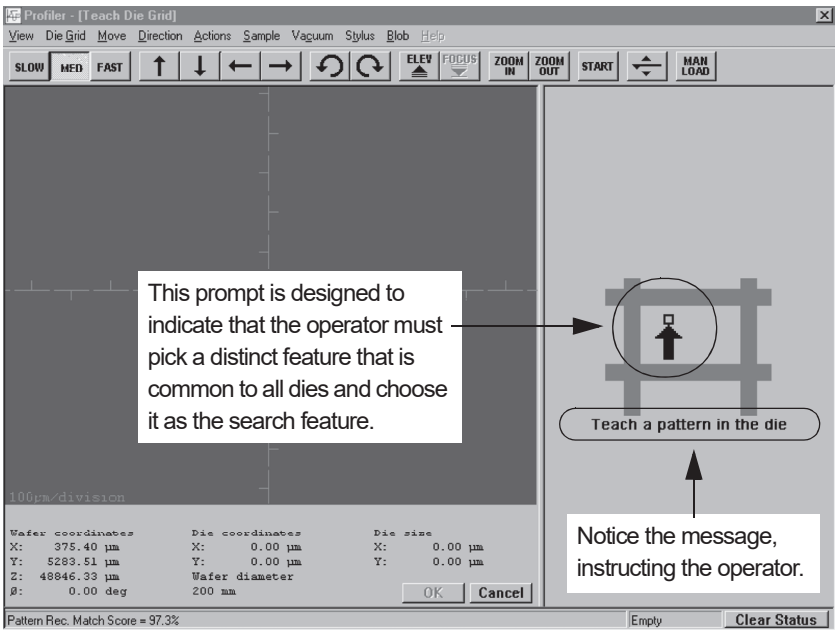
10. Click on **OK** when all variables are correct.

Figure 5.19 *Teach Die Grid - Teach First Position*



11. Teach the upper left inside corner of the die: (follow the instructions on the screen)
    - Position the die image using the arrow buttons so that the upper left corner of the die is in the field of view.
    - Position the mouse cursor at the left inside corner of the die, as indicated in the *Figure 5.19* illustration, and click.

Figure 5.20 *Teach Die Grid - Teach Feature*

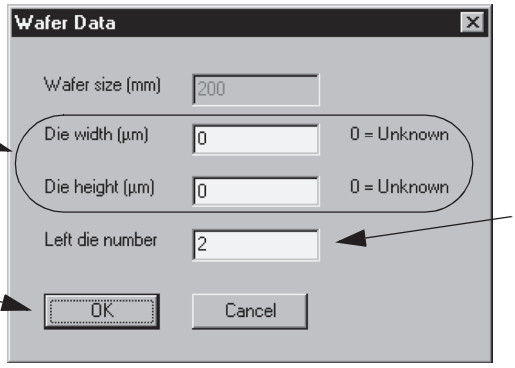


Step 12 Use the arrow buttons to locate a distinct feature. Use the click and drag procedure to draw a box around the feature. The system displays a message if the box is too small or too large.

12. Teach a pattern in the die:
    - Using the arrow buttons, locate a feature that is present in every die. The pattern should be distinct from other nearby features.
    - Click and drag to draw a box around the feature. Start at the upper left corner and drag across the feature so that it is centered in the box when the mouse button is released.

    The instrument centers the pattern in the image crosshairs twice. The Wafer Data dialog box appears. (See *Figure 5.21*):

Figure 5.21 *Wafer Data Dialog Box*



Step 13 If the exact die size is known, highlight the variable box for each dimension and enter the value. Leave it **0** if the system is required to determine the size.

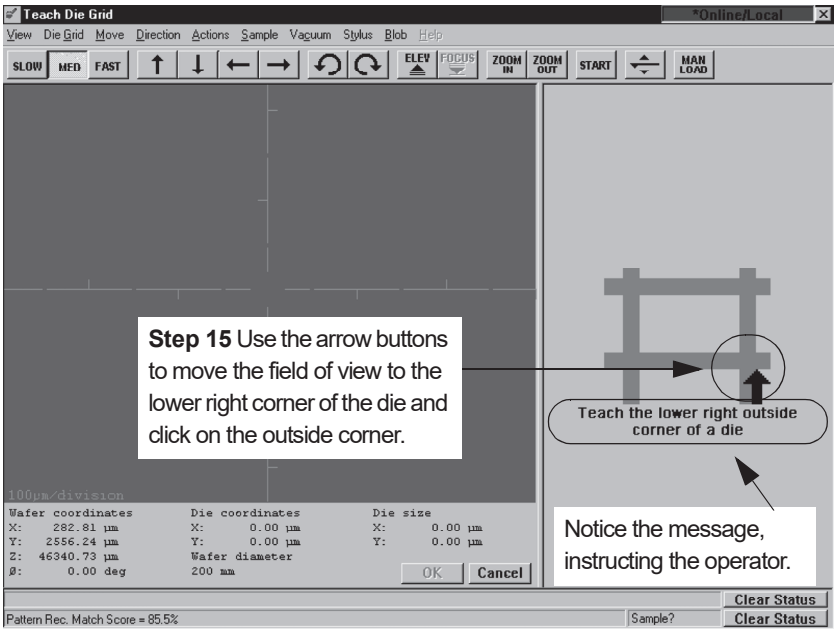
Step 14 When all variables have been set, click **OK** to continue.

This number represents the distance from the left wafer edge that the dies start. The distance is measured in full die widths, in this case, 2.

13. Verify and correct the wafer data and type in die width and height if known.
    - To ***teach*** the die size, leave **Die width** and **Die height** at **0**.
    - **Left die number** tells the instrument how far from the left edge to set its reference point. The value indicates the reference distance in the number of full die widths from the edge.
14. After making any required adjustments, click **OK**.

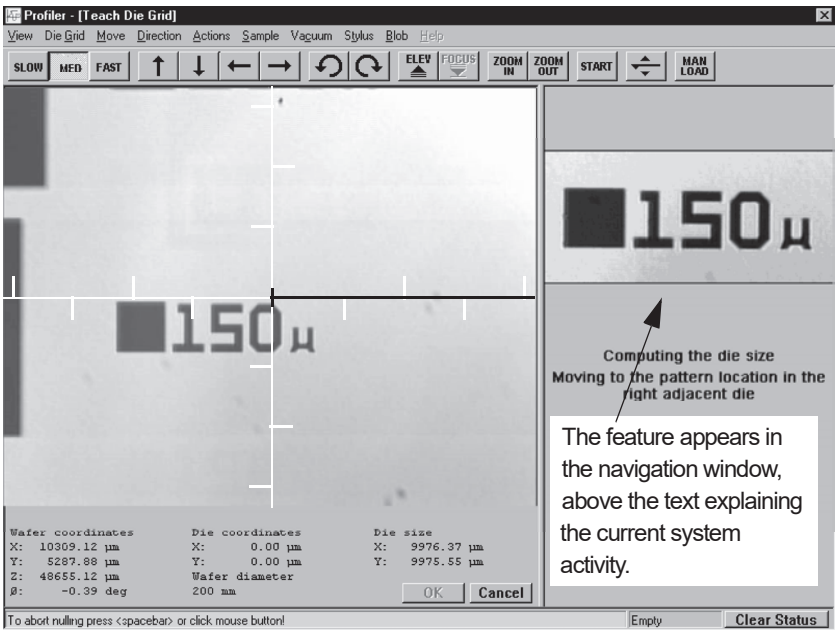
    If the die width and height were not entered, the instrument continues to the third position in the Teach Die Grid sequence:

Figure 5.22 *Teach Die Grid - Lower Right Corner*



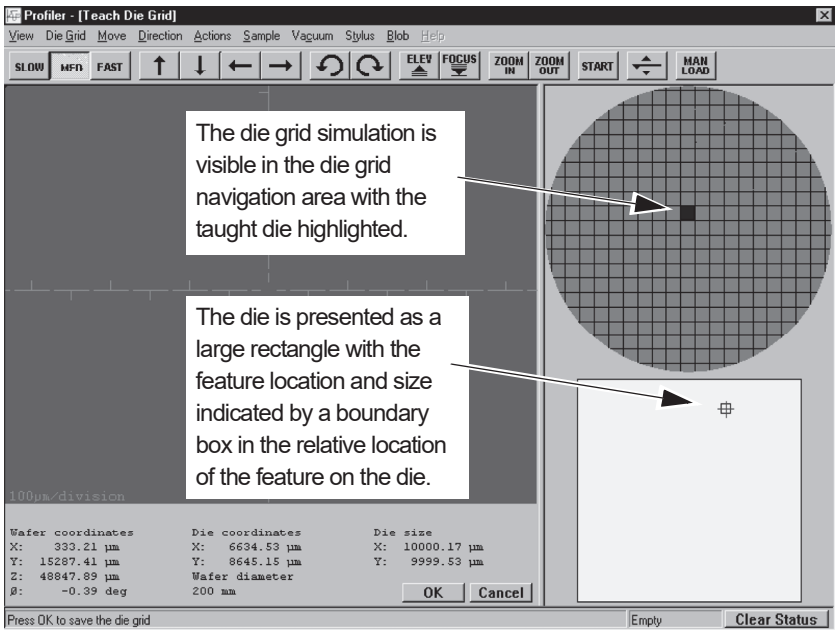
15. Use the arrow buttons to move the die image so the lower right outside corner of the die is visible. Move the mouse cursor to the lower right outside corner of the die and click on it to teach the position.
    - The stage moves to various dies on the wafer, locating the pattern taught in **Step 12** The taught image appears in the navigation window with a comment underneath it that advises the operator which die is being checked. (See *Figure 5.23*.)

Figure 5.23 *Teach Die Grid - With Feature in Navigation Window*



16. When the system completes its check, the die grid is applied. The Teach Die Grid screen changes its die grid navigation window to reflect the current die grid configuration on the wafer. (See *Figure 5.24*.) The taught die appears in dark blue. The operator is prompted to click **OK** to save the die grid.

Figure 5.24 *Teach Die Grid - Die Grid Simulation in Navigation Window*



At the bottom of the die grid navigation window is a representation of the die grid, which appears as a bounded white rectangle. The taught feature is pictured a small bounded box appearing in its relative position in the die. This makes it easier for the operator to locate the feature if a visual search is necessary.

17. Click **OK** (bottom center of the screen) to save the die grid.

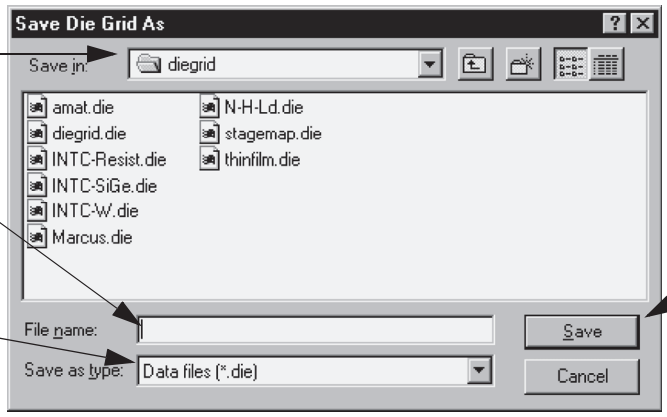
    A save dialog box appears. (See *Figure 5.25*.)

***Figure 5.25 Save Die Grid As** Dialog Box*

Step 18 Choose the location where the die grid is to be saved by clicking in the down arrow and selecting the appropriate directory.

Step 20 Type in the name of the new die grid.

Step 19 Choose the format for the die grid to be saved in by clicking the down arrow and choosing the appropriate format. It should be Data files (***.die**).



Step 21 After completing **Step 18** - **Step 20**, click on **Save**.

18. Choose the drive and directory for storage of the die grid file. (See *Figure 5.25*.)
19. Ensure that the proper file format is chosen for saving the die grid file. Click on the **Save As Type:** menu arrow to display its menu and choose the required format from the menu. (See *Figure 5.25*.)
20. Type a name for the die grid in the **File name:** variable box. (See *Figure 5.25*.)
21. Click on **Save**. (See *Figure 5.25*.)

    The extension ***.die** is supplied automatically. Die Grid Navigation is enabled with the new die grid applied. *Using Die Grid Navigation* on page 5-19 describes how to use Die Grid Navigation with sequences.

Loading a Die Grid (Turning ON Die Grid Navigation) for a Single Scan

1. Ensure that the wafer is in place on the stage. It must have the same pattern as that of the die grid being loaded.

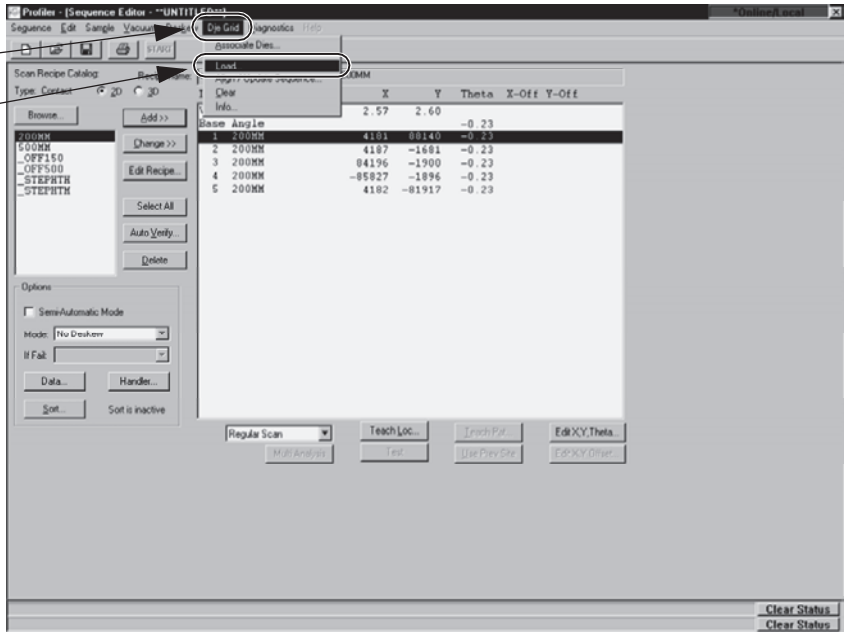
CAUTION: It is very important that the wafer is placed in the same orientation that the die grid was taught. If not, the system cannot find the dies. Use a precision locator to place the wafer in the proper orientation.

2. In the **XY View**, **Scan Editor**, or **Sequence Editor** windows, click on **Die Grid** from the menu bar. (See *Figure 5.26*.)

Figure 5.26 *Sequence Editor with Die Grid Menu*

Step 2 Click on **Die Grid** to display its menu.

Step 3 Click on **Load...** to display the Load Die Grid dialog box.

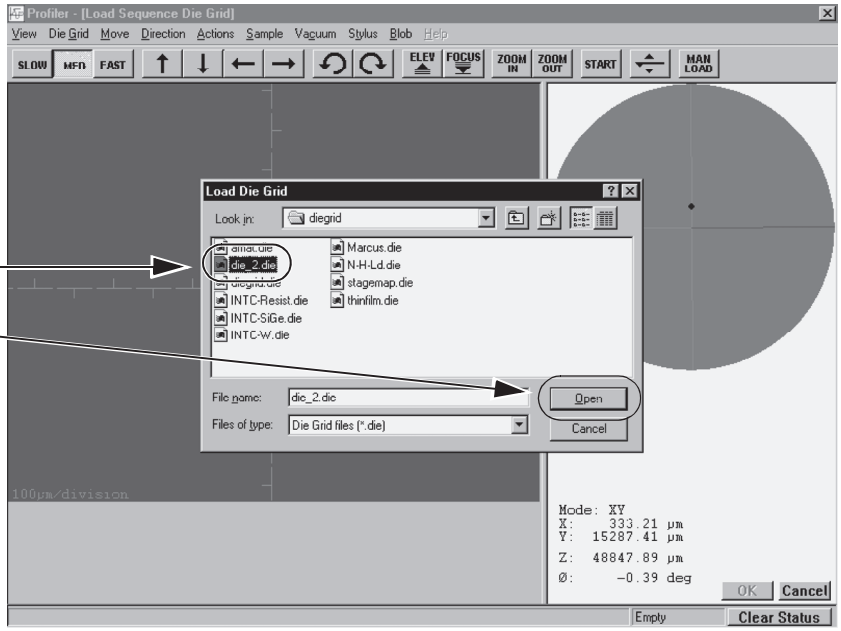


3. Click on **Load** to display the **Load Die Grid** dialog box. (See *Figure 5.27*.)
4. In the **Load Die Grid** dialog box, double-click on the name of the die grid to be used. This displays die grid name in the File Name display box.

Figure 5.27 *Load Sequence Die Grid*

Step 4 To choose a die grid to associate with the sequence:

1. Double-click on the name of the die grid.
2. Click on **Open** to load it.



5. Click on **Open** to load the die grid.

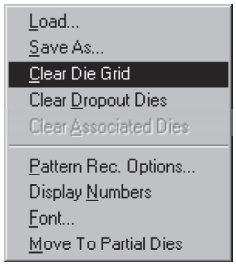
   The system nulls the stylus and begins to search for the pattern that is displayed on the right side of the screen. After it successfully locates the test pattern, the die grid is loaded.

   Die Grid navigation is now active and the die grid selected is applied.

Clearing a Die Grid (Turn OFF Die Grid Navigation)

1. Go to the **Teach Scan** window.
2. Click the **Die Grid** menu, and select **Clear Die Grid**. (See *Figure 5.28*.)

Figure 5.28 *Die Grid Menu From the Menu Bar*

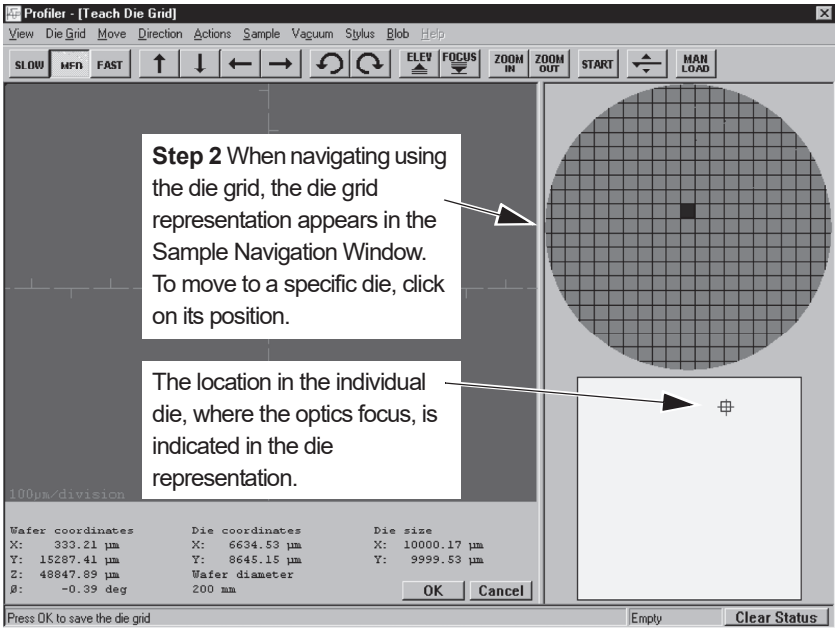


Standard navigation is active again.

Navigating Across the Wafer Using the Die Grid

1. Load a die grid using the procedure in *Loading a Die Grid (Turning ON Die Grid Navigation) for a Single Scan* on page 5-28)
2. Die Grid Navigation uses the representation of the sample that appears in the Sample Navigation Grid at the right of the XY View screen. To move the to a specific die, click on its location. The system moves the stage to that die and focuses on the feature. The feature's position is indicated in the die representation below the Sample Navigation Grid.

Figure 5.29 *Die Grid Navigation*



Enabling the Dropout Die Option

Go to the **Teach Scan** window, and press the **SHIFT** key while clicking the dies in the Die Grid Navigation Window that are to be dropped out. These dies are not scanned.

The die is blacked out. To restore a dropped out die, click it again.

Clearing Dropout Dies From the Grid

From the **Die Grid** menu, click on **Clear Drop Out Dies**. The dies are restored to availability for scan purposes.

Moving to Partial Dies

1. From the **Die Grid** menu select **Enable Partial Die** to enable the Partial Die option.
2. Go to the **Teach** window, click on **Die Grid**, then click on **Move To Partial Dies**. (See *Figure 5.28*.)
3. In the Die Grid Navigation Window, click on the partial die to navigate to it.

Displaying Grid Numbers in the Die Grid Navigation Window

From a **Teach Scan**/**Site** window, click on **Die Grid**, then click on **Display Numbers**. (See *Figure 5.28*.)

If the numbers are too small to see, increase the size of the Die Grid Navigation Window by clicking and dragging the window's vertical separator bar to the left.

To Change the Font and Color of the Grid Numbers

1. Go to a **Teach Scan**/**Site** window, click on **Die Grid**, click on **Font**.

   A standard font dialog box appears.

2. Select the font attributes desired and click **OK**.

USING BLOB ANALYSIS (CENTER OBJECT SEARCH)

Introduction

Blob, or Center Object Search, locates features by their mass distribution (general shape), which might not be apparent from the two-dimensional video image. To use Center Object Search, first store the image of the object by teaching it. The instrument compares the stored image with features within its search area, looking for a similar mass distribution. When the instrument finds a similar object, it positions the scan, orienting the center of the scan line or scan area (3D) with the center of the object.

Center Object Search works best with features that are rounded or conical.

Starting Blob Analysis

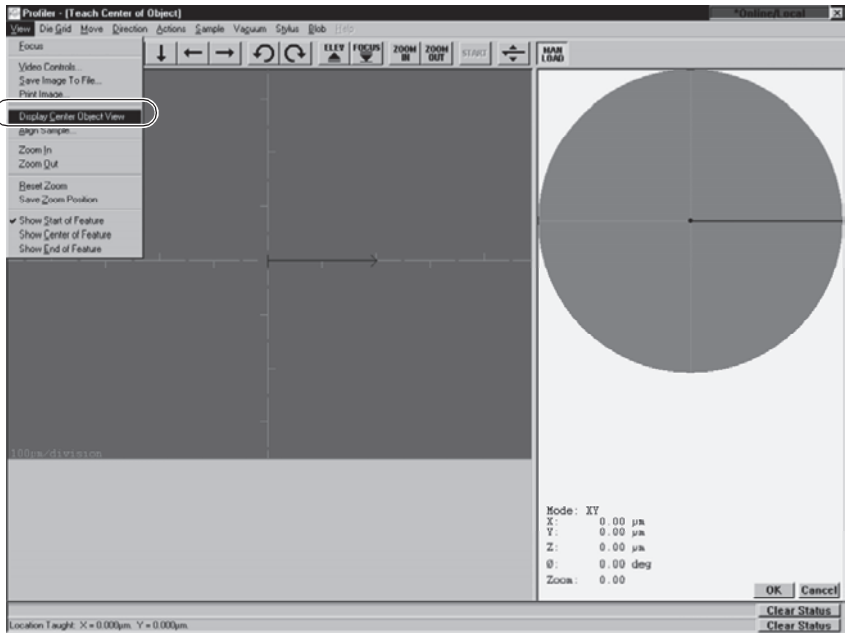
1. With the object in question displayed in the XY View video screen click on View to display its menu.

2. Select **Display Center Object View** from the **View** menu. (See *Figure 5.31*)

Figure 5.30 *XY View Screen – View Menu*

Step 1 Click on **View** to Display its Menu.

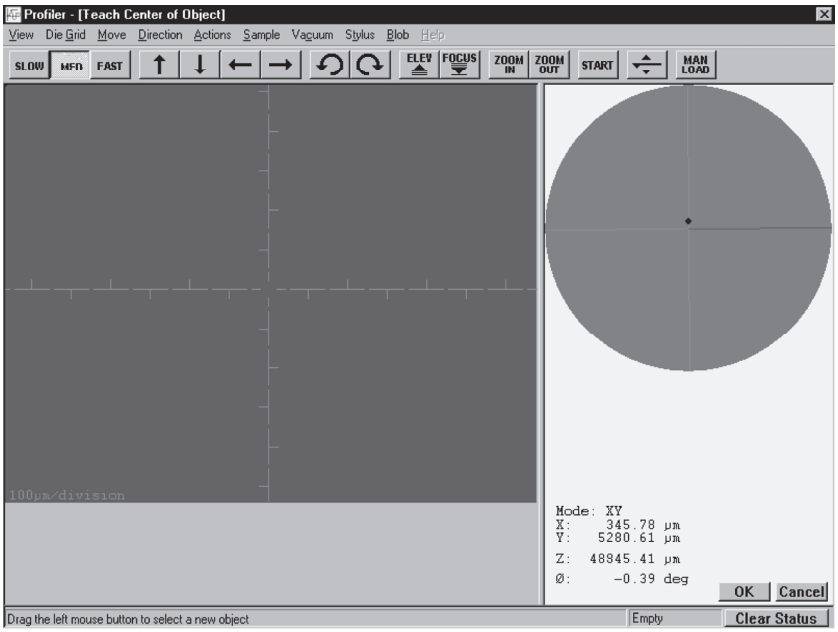
Step 2 Choose **Display Center Object View** from the View menu.



The Teach Center Object window appears. (See *Figure 5.31*)

3. In the Video Display, locate the object to be scanned.

Figure 5.31 *Teach Center Object Window*



4. Click and drag the cursor box around the object, placing its center dot on the object's center of mass.

   The instrument positions the object in the center of the video image.

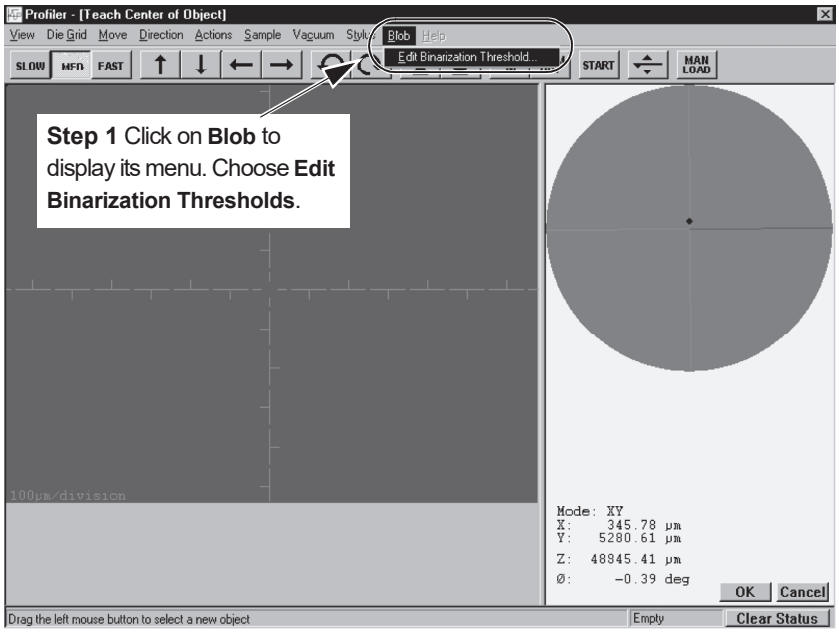
   The instrument uses pattern recognition to analyze the object. The object's pattern is stored with the recipe and made available each time the recipe is used with Display Center Object View checked.

   If the instrument is having trouble finding the object, it might help to edit the binarization threshold, that is, change the level of contrast the instrument uses in recognizing the object. (See *Changing the Level of Contrast* on page 5-34.)

Changing the Level of Contrast

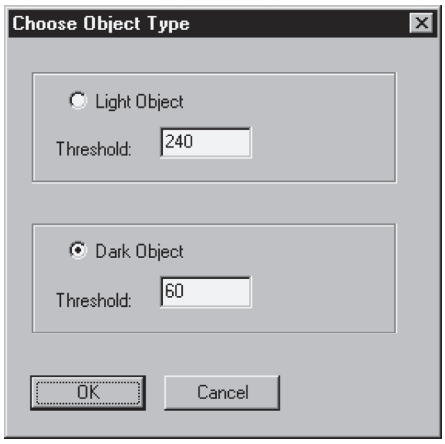
1. Click the **Blob** menu and select **Edit Binarization Thresholds**. (See *Figure 5.32* and *Table 5.9 on page 5-9*.)

Figure 5.32 *Teach Center of Object Screen*



The Select Object Type dialog box appears. (See *Figure 5.33*):

Figure 5.33 *Select Object Type Dialog Box*



- If **Dark Object** is selected, raise the threshold.

  A threshold of **0** accepts only objects of very high contrast—black objects against a white background. The highest threshold, **256**, accepts a very low contrast object—gray object against a lighter background.

- If **Light Object** is selected, lower the threshold.

  A threshold of **0** in this case recognizes very low contrast objects—gray objects against a darker background. A threshold of **256** recognizes high contrast objects—very bright objects against a very dark background.

2. Click **OK** to accept the settings and close the dialog box.

ALIGNING THE SAMPLE

Introduction

This procedure aligns the sample image with the X-axis of the view screen using a straight feature on the sample. Two methods for accomplishing this, each of which rotate the stage (theta movement) to accomplish the alignment, are detailed in the following sections. With the sample features aligned with the X-axis, more accurate scans can be taken and die grid navigation is more accurate.

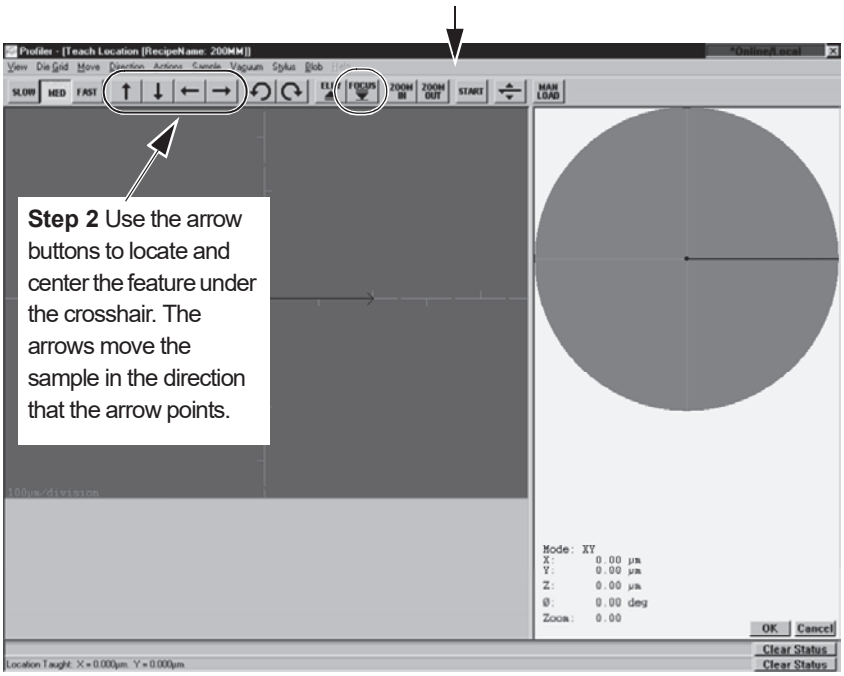
Procedure

Aligning the Sample with the Instrument

This procedure assumes that the sample is already on the sample stage and ready for alignment. The sample must have a straight, easily discernible feature that can be used to aligned the sample features with the X-axis of the XY view screen.

1. Click on the **FOCUS** button in the tool bar. The stylus nulls on the sample surface and the sample image comes into focus.

Figure 5.34 *Arrow Button Movement - Scan Offset Calibration*



2. Using the linear movement arrow buttons, locate the center of the feature to be used for alignment. (See *Figure 5.34*.)

CAUTION: It is very important that the chosen feature be such that it lies in a straight line across the X-axis of the sample. A thin line is best for use in the alignment procedure.

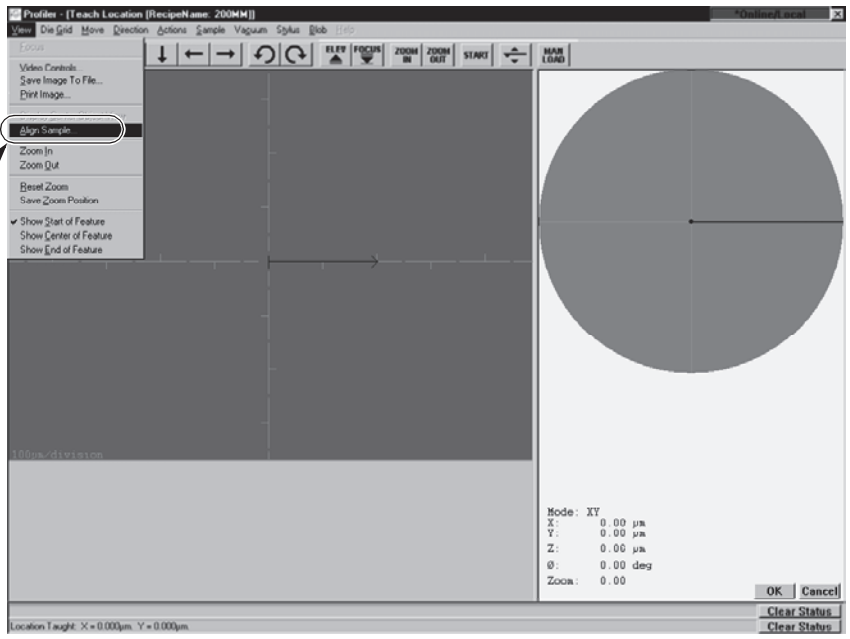
NOTE: The arrows move the stage not the optics.

3. Use the arrow buttons to approximately center the screen crosshair in the center of the feature. (Or, move the cursor to the center of the feature and click. This should move the crosshair to that location.)

4. Click on **View** in the tool bar to display its menu. In the menu, click on **Align Sample**. (See *Figure 5.35*.) This sets up the **Alignment Sample** procedure which aligns the XY axis of the screen with the chosen feature.

Figure 5.35 *Align Sample Procedure - Scan Offset Calibration*

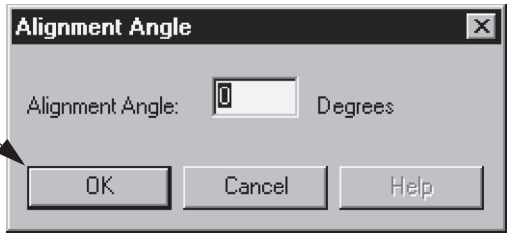
Step 4 To align the Stylus Alignment Tool with the XY axis of the screen, click on **Align Sample**.



5. A dialog box appears requesting input of the intended alignment angle. The default is **0** which aligns the feature with the X-axis after the procedure is complete. Click on **OK** in the dialog box to accept the **0** value. (See *Figure 5.36*.)

Figure 5.36 *Setting Alignment Angle*

Step 5 Click on **OK** to accept the "**0**" angle alignment.



6. Using the **right** arrow button (→), scroll across the feature to the left portion of the feature. Stay close to the feature, and stop when a reasonable distance has been covered (or at the end of the feature if it is small).
7. Place the crosshair cursor on a portion of the feature that is easily duplicated at its other end and click with the left mouse button. The system performs adjustments which align the screen crosshair to the feature at the point of contact.

8. The message prompt displays at the bottom left of the screen, "**Press OK to accept the first alignment position**." Click **OK,** at the bottom right of the screen, to accept the first alignment position.
9. Using the **left** arrow button (←), scroll across the center of the feature (starting point). Stay close to the feature, and stop when the sample has move a significant enough distance to give the software a long interval over which to align the sample with the X-axis. Place the crosshair cursor **over the same portion of the feature that was used to set the first position** and click with the left mouse button. The system performs final adjustments, aligning the feature with the XY axis.
10. The message prompt displays "**Press OK to accept the second alignment position.**" Click **OK,** at the bottom right of the screen, to accept the second alignment position.
11. After the adjustments have been completed by the system, the message prompt at the bottom of the screen indicates that the **OK** button must be clicked to accept the new alignment adjustment. Click **OK** (bottom right of screen) to accept or click **Cancel** to run a new alignment angle calculation.

    This completes the Align Sample procedure.

Manual Alignment of the Sample

The sample can be aligned manually using the XY view screen in conjunction with the theta (rotational) movement arrow buttons on the tool bar.

1. Follow **Step 1** through **Step 3** in *Aligning the Sample with the Instrument*.
2. Use the theta movement arrows in the tool bar (in conjunction with the other arrow buttons as necessary) to rotate the chosen feature until it aligns with the X-axis on the XY view screen.

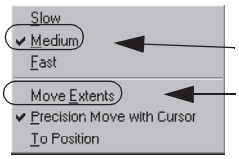
    a. Click the  button for counterclockwise rotation.

    b. Click the  button for clockwise rotation.

    The Theta movement buttons may rotate the image past the point required to align the sample features with the X-axis. If this happens, the following adjustments to the theta movement can be made:

    i. Check the Speed Setting in the **Move** menu. In the tool bar at the top of the XY view screen, click on **MOVE** to display the menu. (See *Figure 5.37*.) Three speeds (which are actually movement increments) are available: **Slow**, **Medium** and **Fast**. If the image always rotates past the X-axis, refine the movement by moving to the next slower movement. If the **Slow** setting still does not allow alignment, move to step *ii.*

Figure 5.37 *Move Menu*



Click on the desired speed in the **Move** menu. The chosen speed has a check in front of it.

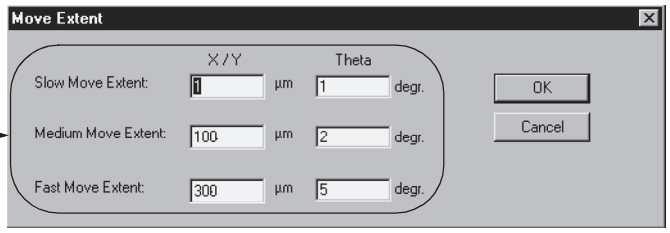
Click on **Move Speeds** to display the **Move Extent** dialog box. (See *Figure 5.38*.)

ii. The amount of rotation in the theta arrow buttons is set in degrees in the **Move Extents** dialog box with each setting (**Slow, Medium,** or **Fast**) having its own rotation in degrees.

Figure 5.38 *Move Extent Dialog Box*

There are three movement speeds available in the **Move** menu. All three are defined in the **Move Extents** dialog box. For each 100 µm the stage moves 1°.

EXAMPLE: In the **Fast Move Extent** box is set to 300. This means a 3° movement with each click on a theta arrow.



Check the **Slow Move Extent** box and set it as low as **0.01**. Click on **OK** to set the new speed.

iii. In the **XY** view screen, click on **Move** and choose **Slow**. (See *Figure 5.37*.) The theta movement should now be small enough for proper alignment.