zygo®

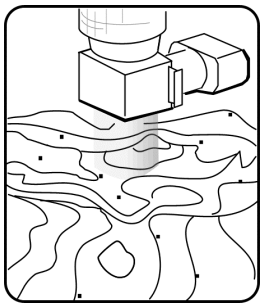
OMP-0360F

Microscope MetroPro Applications

Micro.app **MicroErr.app**

This booklet is a quick reference; it assumes that you are familiar with MetroPro and the instrument. Information on MetroPro is provided in *Getting Started With MetroPro*, OMP-0398, and the *MetroPro Reference Guide*, OMP-0347. For information on the instrument, please refer to the applicable Zygo manual. Information herein is applicable as of MetroPro version 7.7.0.

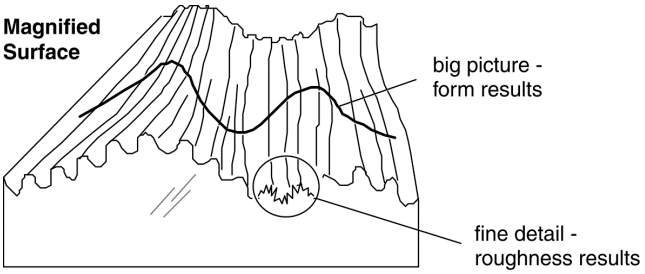
The Microscope Applications



The MetroPro Microscope Application is a general-purpose application used for measuring the surface structure and roughness of test parts. It is a good application to start with when learning MetroPro software or when creating your own specialized applications. The Microscope Error Application is used to create system error files to improve instrument performance.

Both microscope applications support Zygo's microscopes, including the NewView and Maxim. Both applications are supplied as standard with MetroPro software; no unique license is required. For information on licensing, see the *Getting Started With MetroPro* manual.

Typically, surface structure or texture results are available for form, also known as waviness, and roughness. Graphics and results are available for three dimensional areas, as well as two dimensional cross sections or slices.



This booklet describes:

- **Micro.app** General-purpose application for Zygo microscopes.
- **MicroErr.app** The Microscope Error application is used to create system error files; which map out systematic optical errors for the instrument and objectives. The system error file is subtracted from subsequent measurements to improve instrument performance.

The Microscope Application (Micro.app):

- Provides numerous surface structure graphic views (plots) and numeric results.
- Displays and provides statistics on results over several measurements.
- Has user-selectable data filtering to isolate and highlight the components of surface texture.
- Can output results as printed screens and as data files. Result data can be sent to other networked computers.
- Serves as a "template" for making your own custom applications.

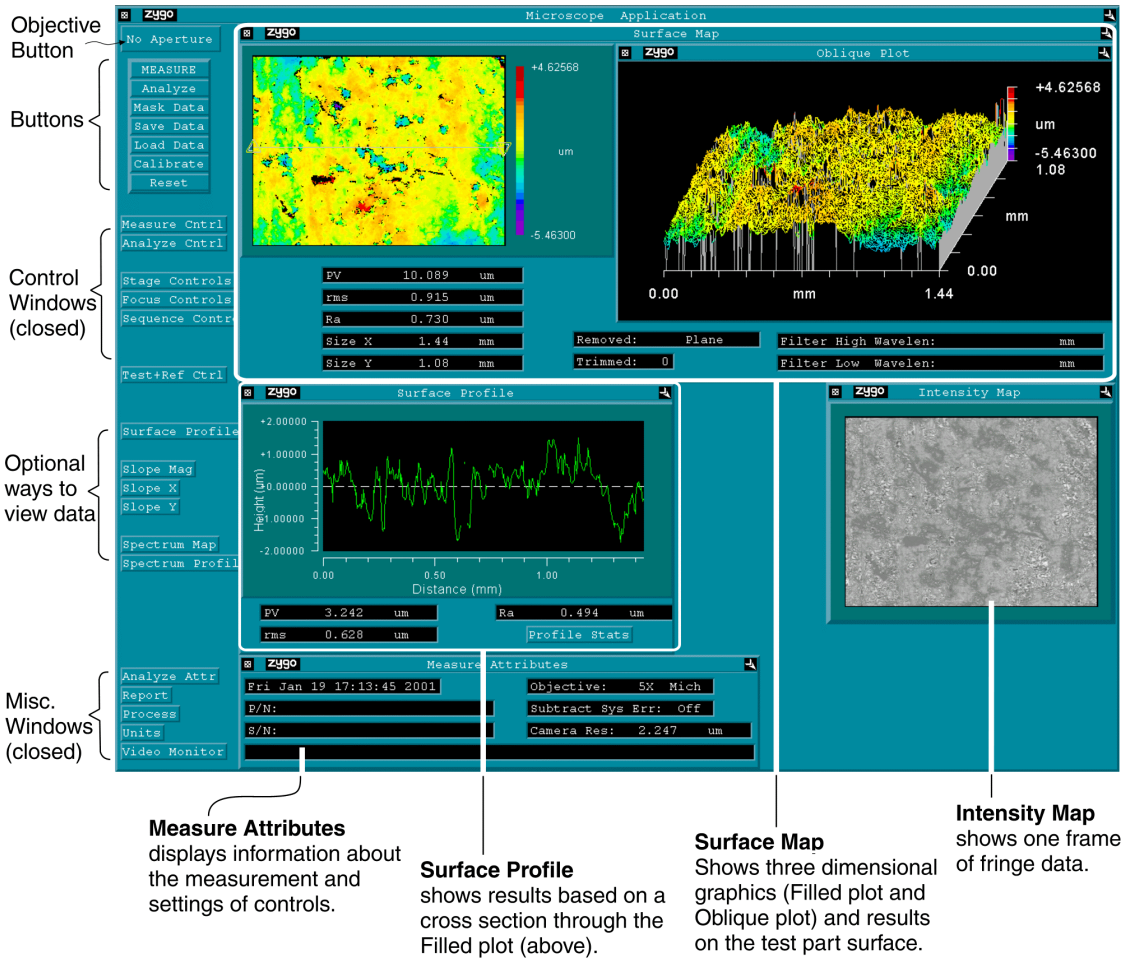
The Microscope System Error Application (MicroErr.app):

- Helps you get the best possible accuracy out of your instrument.
- Is set up for quick and easy measurement of the Precision Reference Flat.
- Provides visual feedback to confirm the data.

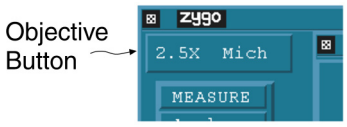
Micro.app

To open the application, click on the Micro.app icon. If the icon is not on the MetroPro base window, then use the Load Application command from the MetroPro Window menu to first load the application icon.

The Microscope Application Screen



The Objective Button



Alternate Button Layout

```
Obj : 100X  Mirau
Zoom: 1.0 X
Res : 0.11 µm
FOV : 0.07 x 0.05 mm
```

To select the objective in use, click the Objective button with the left mouse button.

To display the current instrument settings, choose the Layout → Obj/Zoom/Res/FOV command from the Button's menu.

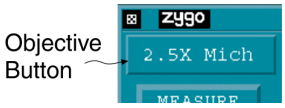
Obj is the current objective
(with motorized turret this automatically updates).
Zoom is the image zoom setting
(with encoded zoom this automatically updates).
Res is the objective lateral resolution.
FOV is the objective field of view (horizontal x vertical).

Guidelines

- *Use a System Error File* - It is recommended that you create a system reference file for the objective in use and then subtract this file from the measurement.
- *Set Light Level with Several Fringes in View* - For the most accurate measurements, set the light level (press F5) when there are several fringes in the field of view.
- *Save Your Changes* - To preserve changes made to the application, select the Save Application command from the Application Window menu. In the File Handler, click the Current Selection box, enter a name for the application file, ending with ".app" and press <Enter>, then click Done.

Making Measurements

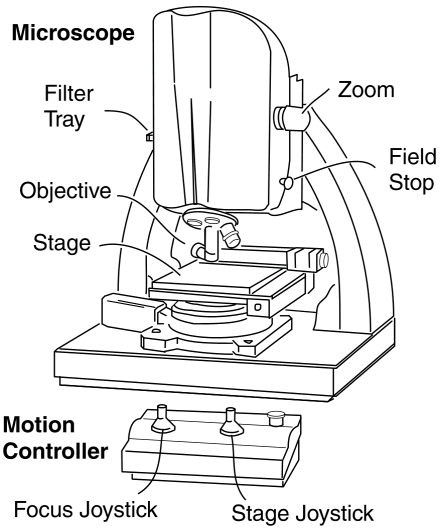
1. Power-up the instrument, start MetroPro, and click the Micro.app icon to open it.
2. Click the Objective button until it displays the objective in use.
3. Place the test part on the stage under the objective. Position the objective at its working distance from the part. *Don't crash the objective into the part or the stage.*
4. Set the Zoom knob to the desired setting; ensure that the software Image Zoom control is set to match. Position the filter tray to FOCUS. Press the **F5** key to adjust the light level. Focus the microscope for a sharp image; there should be visible fringes.
5. If there are not visible fringes, adjust for tilt in the part. To do this, press the F4 key to open the Light Level window, adjust the stage tip and tilt until the Peak Intensity readout is maximized, and press Enter to close the window.
6. Adjust the stage to center the area of interest in view. Place the filter tray to MEAS, press **F5** again to adjust the light level. Refocus for high contrast fringes.
7. Fine-tune focus and stage tip and tilt for surface detail, to null or minimize the number of fringes, and to center the darkest fringe.
8. Press the **F1** key or click the MEASURE button to measure.



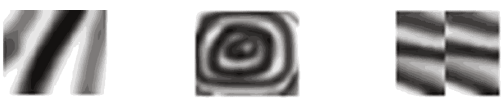
Objective Working Distance (in mm)

2.5X	5X	10X	20X	50X
10.3	9.3	7.4	4.7	3.4

Microscope Controls - NewView 5000



Sample Video Monitor Images



Flat Surface- minimize number of fringes, center darkest fringes.

Spherical Surface- center the fringe pattern.

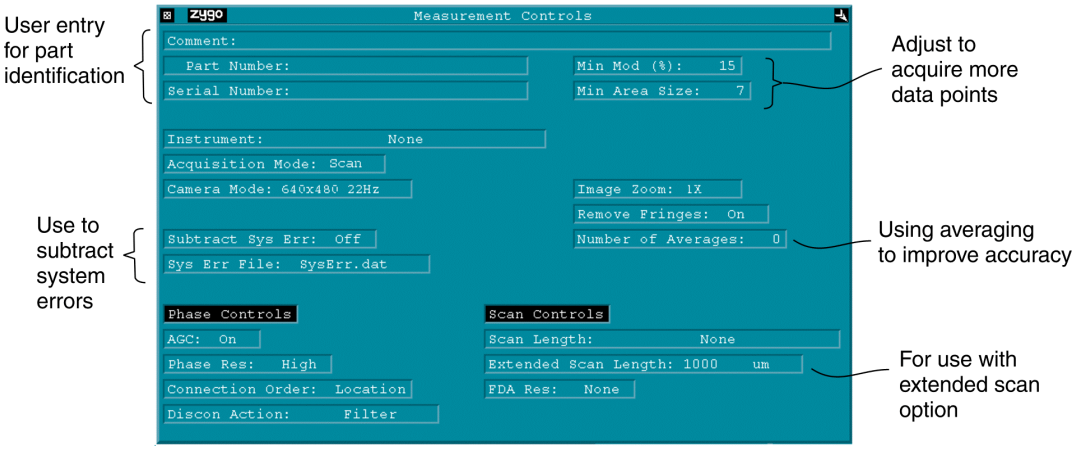
Stepped Surface- position fringes at right angle to the step.

Note: Part must be in focus with fringes to measure.

Micro.app Control Windows

Measure Cntrl

To open this window, click the Measure Cntrl icon. These controls determine the way data is acquired. Make changes before measuring.



Control	Function
Acquisition Mode	Selects the technique used to acquire data. Settings are Scan or Phase. Scan is for the NewView. Phase is for the Maxim.
AGC	Selects if AGC (Automatic Gain Control) is used to adjust for optimum light level during the measurement when the Acquisition Mode is set to Phase. For most conditions it should be set to On. When AGC is set to Off, the light level is set by Light Level control.
Camera Mode	Selects the effective camera size in pixels. More pixels resolve smaller details, but increase processing time.
Extended Scan Length	For NewView with extended scan option only. Specifies the length of the scan. The Scan Length control must be set to Extended. The value entered should be the vertical range of detail in the part plus 10%.
FDA Res	NewView. Selects the resolution used during analysis when Acquisition Mode is set to Scan. Use Normal when measuring rough surfaces; use High when measuring smooth surfaces and steps.
Image Zoom	For microscopes with image zoom option. Set the control to match the setting selected on the zoom thumbwheel on the microscope. This ensures that lateral type results are calibrated.
Min Area Size	Specifies the number of data points in a valid region. Decrease to allow smaller areas. Increase to accept larger areas and reject smaller.
Min Mod (%)	Specifies the minimum modulation necessary for a valid data point. Decrease to accept areas with poor fringe contrast or low reflectivity. Increase to exclude unwanted data points.
Number of Averages	Specifies the number of measurements that are averaged together, thus improving repeatability. Averaging increases processing time.

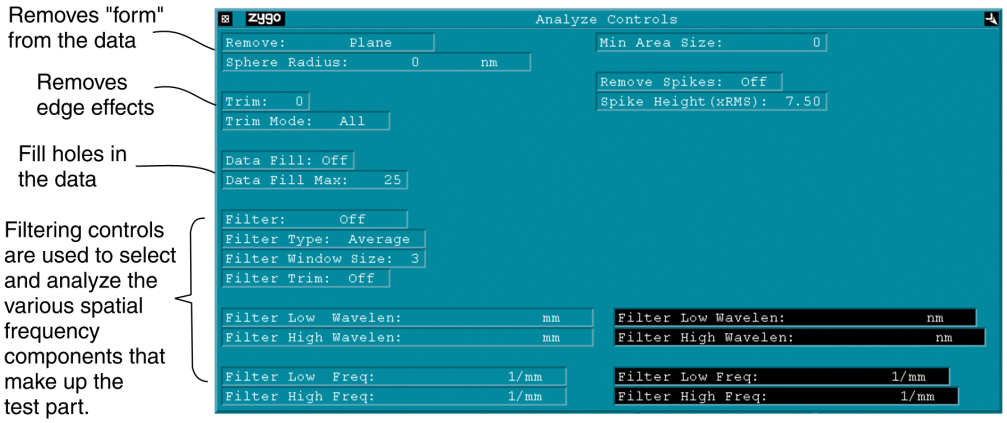
(continued)

Measure Cntrl (continued)

Control	Function
Phase Res	Selects the resolution of the calculation of phase values when Acquisition Mode is set to Phase. High provides higher resolution, but lower total range of heights. High is the suggested setting for microscopes.
Scan Length	NewView. Selects the vertical scan length. The longer the scan, the greater the height measuring capability, and the longer the time required to make a measurement. Set to the minimum value to encompass the part detail.
Subtract Sys Err	Activates a system error correction function to improve measurement accuracy. An error file must exist for the specific objective in use.
Sys Err File	Specifies the name of a data file to subtract from measurements.

Analyze Cntrl

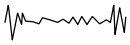
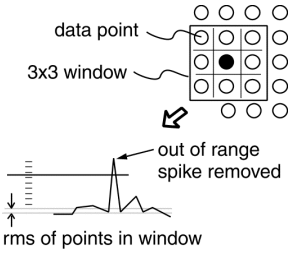
To open this window, click the Analyze Cntrls icon. These controls select the way data is analyzed. After changing settings, click the Analyze button.



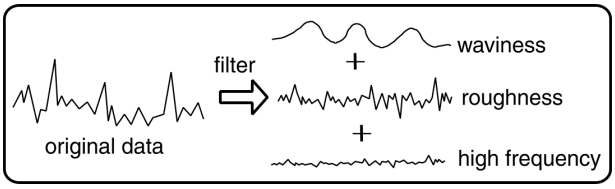
Control	Function
Data Fill	When On, holes or missing data points are filled for display in plots, based on the setting of the Fill Max control. When Off, missing data points are not filled. The default setting is Off. This control does not change the actual data.
Data Fill Max	Specifies the maximum size of a data hole that is filled when the Fill Data control is On. It is the total number of pixels in any one hole.
Filter	Activates data filtering options. Filtering is used to highlight the roughness (high frequency components) or waviness (low frequency components) of a test part. Settings are Off, Low Pass, High Pass, Band Pass, and Band Reject. The affect of filtering varies based on the settings of the Filter Type and Filter Window Size controls. Off disables data filtering; all other filter controls are ignored. See the “Using Filtering” section for greater detail.

(continued)

Analyze Cntrl (continued)

Control	Function
Filter High Freq and Filter High Wavelen	Specifies the frequency (or wavelength) of the higher cutoff point between roughness and high frequency data. Applicable Filter control settings: Low Pass, Band Pass, Band Reject. Applicable Filter Type control settings: FFT Fixed.
Filter Low Freq and Filter Low Wavelen	Specifies the frequency (or wavelength) of the lower cutoff point between waviness and roughness data. Applicable Filter control settings: High Pass, Band Pass, Band Reject. Applicable Filter Type control settings: FFT Fixed.
Filter Trim	Selects how filtering interacts with edge data. When On, filtering performs normally and some edge data is lost. When Off, edge data is preserved that is usually lost due to filtering. Set to On, if you notice "ringing" effects at the data edges (for example: ).
Filter Type	Selects the filtering algorithm when the Filter control is activated. The choices are: Average, Median, 2 Sigma, FFT Auto, and FFT Fixed. *Average* uses all valid data points in each filter window and averages them. *Median* uses the middle value of all valid data points in each filter window. *2 Sigma* uses data points that are within two times the rms value in each filter window and disregards values outside this range. When the Average, Median, or 2 Sigma filters are used, the Filter High/Low Wavelen (or Freq) controls are ignored. *FFT Auto* and *FFT Fixed* use a Fast Fourier Transform algorithm; and the Filter Window Size control is ignored. FFT Auto automatically selects filter cutoff points based on the test data; it should be used as a starting point only. FFT Fixed sets filter cutoffs based on the entries in the Filter High/Low Wavelen (or Freq) controls.
Filter Window Size	Selects the number of data points used to generate a new filtered data point when the Filter Type control is set to Average, Median, or 2 Sigma. As the window size is increased the affects of filtering are increased.
Remove	Specifies the surface to subtract from measurements to minimize form. Settings are Plane, Piston, Sphere, and Cylinder.
Remove Spikes	When On, spikes are removed from the data based on the setting of the Spike Height control. When Off, data spikes are not removed.
Spike Height (xRMS)	For each point, the rms height of the surrounding points is calculated; if the point height is greater than the entered value times the rms it is removed. An entry is ignored unless the Remove Spikes control is On. 
Trim	Specifies the number of pixel layers to remove from edges and from isolated obscurations. Works in conjunction with the Trim Mode control.
Trim Mode	Selects where trimming is applied; settings are Outside or All.

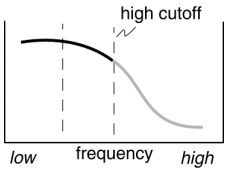
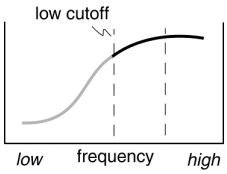
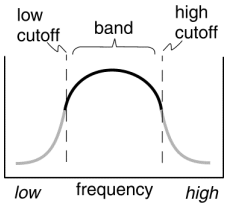
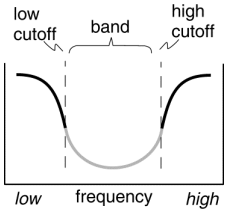
Using Filtering



By digital filtering of the test data, the surface characteristics of the test part are broken down into waviness, roughness, and high frequency results. Because filtering modifies the original data it should be used with caution, as filtering can drastically alter the test results. An easy way to observe the effects of filtering is to make the first measurement with the Filter control Off. Then change the filter controls, click the Analyze button, and observe the outcome.

There are a number of controls for setting filtering parameters, some are interrelated and are only functional when a specific type of filtering is selected. The use of the terms "frequency" and "wavelength" as they relate to filtering is shown below.

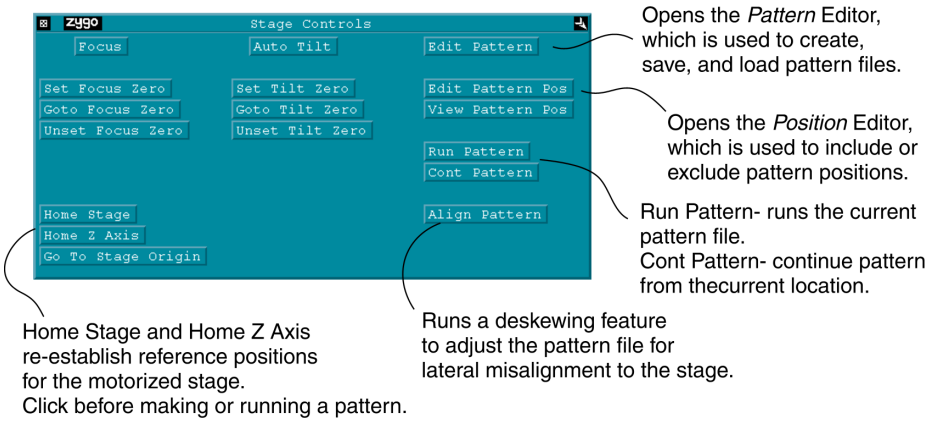
Term	Waviness	Roughness	High Frequency
Frequency	low	middle (mid)	high
Wavelength	long	moderate	short

Filter	Example	Description
Off	-	All data is unfiltered.
Low Pass		Low frequency or waviness data is highlighted; roughness is removed. The effect varies based on the Filter Type control. Average, Median, and 2 Sigma work in conjunction with the Window Size; the larger the size the greater the effect. FFT Fixed sets the cutoff with Filter High Wavelen/Freq.
High Pass		High frequency or roughness data is emphasized; waviness is removed. The effect varies based on the Filter Type control. Average, Median, and 2 Sigma work in conjunction with the Window Size; the larger the size the greater the effect. FFT Fixed sets the cutoff with Filter High Wavelen/Freq.
Band Pass		Data in the center of the band, between two cutoff values, is passed and analyzed. The Filter Type control must be set to FFT Fixed or FFT Auto. FFT Fixed lets you set the cutoff locations with the Filter High/Low Wavelen/Freq controls. In FFT Auto, the software arbitrarily sets the cutoffs as a starting point; you should switch to FFT Fixed and enter your own cutoffs. The exact filter values to enter vary due to the test part, the objective, and your testing criteria.
Band Reject		Data in the center of the band, between two cutoff values, is rejected. The Filter Type control must be set to FFT Fixed or FFT Auto. FFT Fixed lets you set the cutoff locations with the Filter High/Low Wavelen/Freq controls.

Stage Controls

To open this window, click the Stage Controls icon. Stage controls provide access to the tools used when creating and working with programmable motorized stages. Some focus and tilt controls are provided if the instrument has difficulty when running a pattern due to tilt in the part.

The Stage Controls Window



After starting the NewView and before making or running a pattern, click the Home Stage and Home Z Axis buttons to establish reference locations.

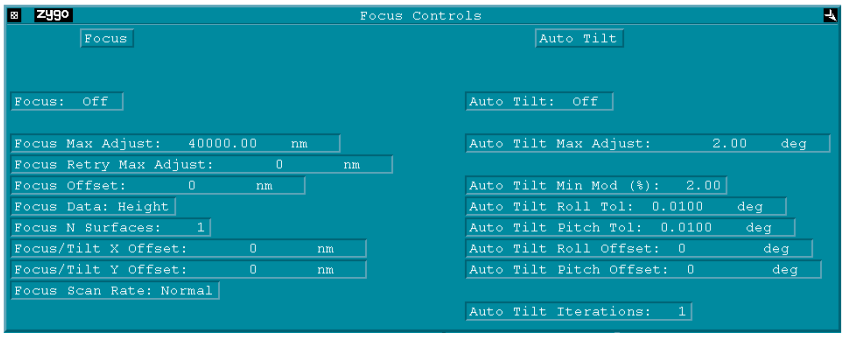
Focus Controls

To open this window, click the Focus Controls icon. The controls in the Focus Controls window are for using auto focus and auto tilt, which is only applicable for microscopes with programmable stages. Auto focus and tilt works best when measuring a series of similar test parts.

Both auto focus and auto tilt use a series of quick test measurements to find and adjust part positioning. The controls provide tools to fine-tune this technique. Auto focus controls drive the motorized z-axis to find the optimum location for fringes and focus. Auto tilt controls drive the roll and pitch (tip and tilt) motorized stages to minimize the number of fringes.

These functions are licensed as option “Scan Focus and Tilt” in the MetroPro Edit/View Licenses window.

The Focus Controls Window



Focus Controls (continued)

Control	Function
Focus button	When clicked, an auto focus adjustment is attempted based on the settings of the focus controls.
Focus	When On, auto focus is attempted before each measurement.
Focus Max Adjust	Specifies the maximum distance (in the z-axis) to scan to look for proper focus.
Focus Retry Max Adjust	Specifies the distance to scan for a second attempt at auto focus, when focus fails using the Focus Max Adjust distance.
Focus Offset	Specifies an offset distance (in the z-axis) from where focus is obtained. Auto focus focuses on the portion of the part specified by the Focus Data and Focus Surface controls, this may not be desired as the ultimate location.
Focus Data	Specifies which type of data to examine for the purpose of selecting a surface for auto focus and tilt. Settings are: Height and Intens. Height uses the height data and looks for surfaces of different average height. Intens uses intensity data and looks at the intensity data (fringes removed) for surfaces of different average intensity. (1) The Focus Data control, the Focus N Surfaces control, and the Focus Surface control all work in conjunction. Ultimately, a region of height data is analyzed for the auto focus and tilt calculations. If the part being measured has multiple regions (or surfaces) of different heights or different reflectivities, the controls can be set to select one of those surfaces. These three controls affect the operation of both the auto focus and the auto tilt functions when the Acquisition Mode control is set to Scan, or if the Acquisition Mode control is set to Phase and the Focus Mode control is set to Scan.
Focus N Surfaces	Specifies how many distinct surfaces to expect. See (1) under Focus Data.
Focus Surface	Specifies which surface in the part is used for auto focus and tilt. Settings are Highest and Largest. Highest specifies the highest (or brightest) surface. Largest specifies the surface having the largest number of data points. See (1) under Focus Data.
Focus/Tilt X Offset	Specifies a distance in the x-axis that the part, prior to adjusting instrument focus and stage tilt, is moved to locate it under the focus spot.
FocusTilt Y Offset	Specifies a distance in the y-axis that the part, prior to adjusting instrument focus and stage tilt, is moved to locate it under the focus spot.

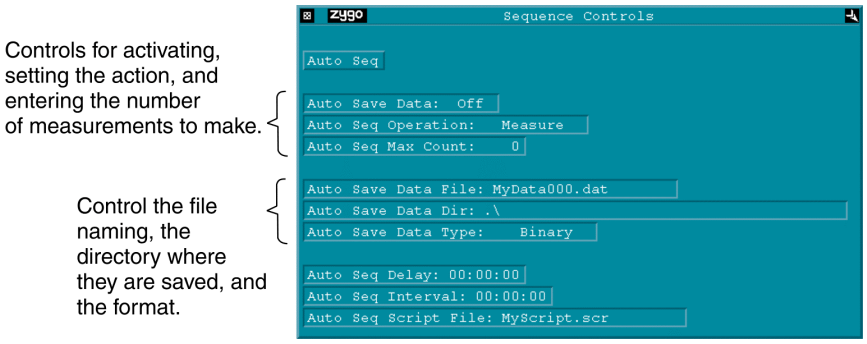
Focus Controls (continued)

Control	Function
Focus Scan Rate	Selects the scan rate used to acquire height data for the auto focus and tilt calculations. Selections are: Normal, Fast, and Slow. Slow uses the same scan rate that is used when acquiring height data for a measurement. The Normal and Fast selections use scan rates that are three and five times faster than Slow, respectively. A slower scan rate provides the most accurate and reliable operation, but takes more time. A faster scan rate takes less time, but may be less accurate or less reliable, especially if the fringe contrast is low. This control affects the operation of both the auto focus and the auto tilt functions when the Acquisition Mode control is set to Scan, or if the Acquisition Mode control is set to Phase and the Focus Mode control is set to Scan.
Auto Tilt button	When clicked, an auto tilt adjustment is attempted based on the settings of the auto tilt controls.
Auto Tilt	When On, auto tilt is attempted before each measurement.
Auto Tilt Max Adjust	Specifies the maximum travel in degrees for pitch and roll adjustments to minimize the tilt in the part.
Auto Tilt Min Mod (%) or Auto Focus Min Mod (%)	This is the minimum modulation (in percentage) necessary to obtain a valid height data point for use in the auto focus and tilt calculations. A lower value includes weakly modulating points. A higher value includes only strongly modulating points. The value is usually a low number, as low as 1. These two controls are redundant - they always have the same value; therefore, either one can be used.
Auto Tilt Roll Tol	Specifies how close the part, in degrees, must be aligned in the roll (tip) axis.
Auto Tilt Pitch Tol	Specifies how close the part, in degrees, must be aligned in the pitch (tilt) axis.
Auto Tilt Roll Offset	Specifies the amount in degrees that the roll (tip) axis is adjusted prior to making a measurement.
Auto Tilt Pitch Offset	Specifies the amount in degrees that the pitch (tilt) axis is adjusted prior to making a measurement.
Auto Tilt Iterations	Specifies how many times to perform auto tilt operation. On some instruments, repetition allows the auto tilt operation to converge and obtain a more accurate adjustment. A value of 2 causes the operation to be performed initially and then repeated. A value of 3 is the highest setting that should be required. This control affects the operation of auto tilt function when the Acquisition Mode control is set to Phase.

Sequence Controls

To open this window click the Sequence Controls icon. The controls in the Sequence Controls window are for automating the capture of data over time. A variety of parameters can be controlled, from the number of measurements, to time delays, and auto file naming.

The Sequence Controls Window



Control	Function
Auto Seq button	Starts an auto sequence based on the setting of the Auto Seq controls. Press <Esc> to cancel an auto sequence.
Auto Save Data	When On, data is automatically saved.
Auto Seq Operation	Determines the auto sequence mode. Measure is a series of measurements. Run Pattern runs the current pattern file. Run Script runs the script file named in the Auto Seq Script File control.
Auto Seq Max Count	Specifies the number of sequences to make.
Auto Save Data File	Specifies the data file name and *selects* the auto save mode with the control's Mode command, when the Auto Save Data control is On. Mode settings are Normal, Auto-Increment, and Prompt. The Auto-Increment setting automatically saves data files and increments the name by one digit, without user input.
Auto Save Data Dir	Specifies the directory where to save the sequenced data files.
Auto Save Data Type	Specifies the data format. Binary is standard MetroPro format. ASCII is text format. Other formats are also available.
Auto Seq Delay	Specifies a time delay before a sequence starts, in hours, minutes, and seconds. This is the delay from when the Auto Seq button is clicked.
Auto Seq Interval	Specifies a time delay between multiple sequences, in hours, minutes, and seconds.

Results

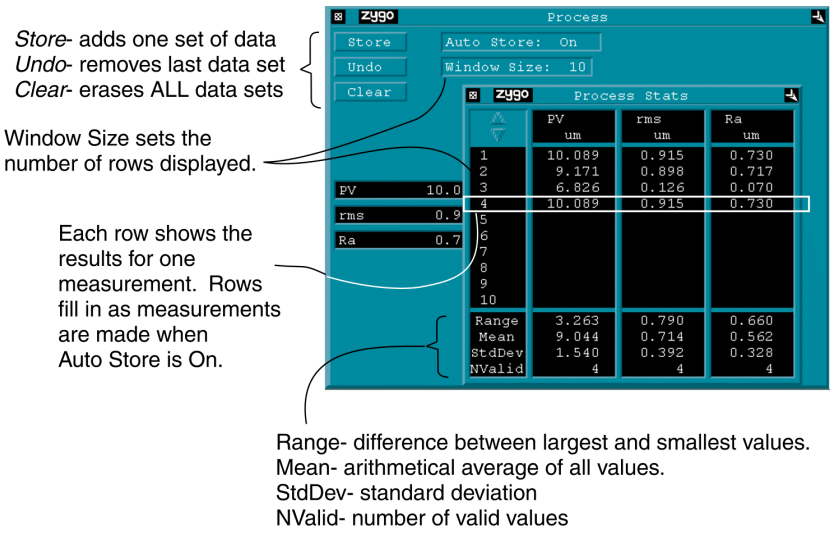
The results shown in the Microscope Application are explained below. For results not listed, or for greater detail, refer to the *MetroPro Reference Guide*.

Result	Description
PV	The height between the lowest and the highest point on the test part surface. 
rms	The root-mean-square deviation of all points from a plane fit to the test part surface. 
Ra	The average roughness, or the average deviation, of all points from a plane fit to the test part surface.
Size X	The dimension of the data set in the X-axis (on-screen horizontal).
Size Y	The dimension of the data set in the Y-axis (on-screen vertical).

The Process Window

To open the Process window, click the Process icon. The Process Window is used to gather results from different windows and view them in one place. To use the Process window, copy results from other windows with the Copy Output Box command. Then select the New Result → Process Stats command; this creates the Process Stats window based on the results in the Process window. Process Stats track results over multiple measurements.

The Process Window



MicroErr.app

The Microscope Error application is used to create system error files; which map out systematic optical errors for the instrument and objectives. The system error file is subtracted from subsequent measurements to improve instrument performance.

Each objective requires a unique system error file; and this file should be created whenever the objective is remove or replaced, or the image zoom setting is changed.

The Precision Reference Flat

Precision Reference Flat

When creating a system error file it is necessary to measure a component of known high quality, such as the Precision Reference Flat.

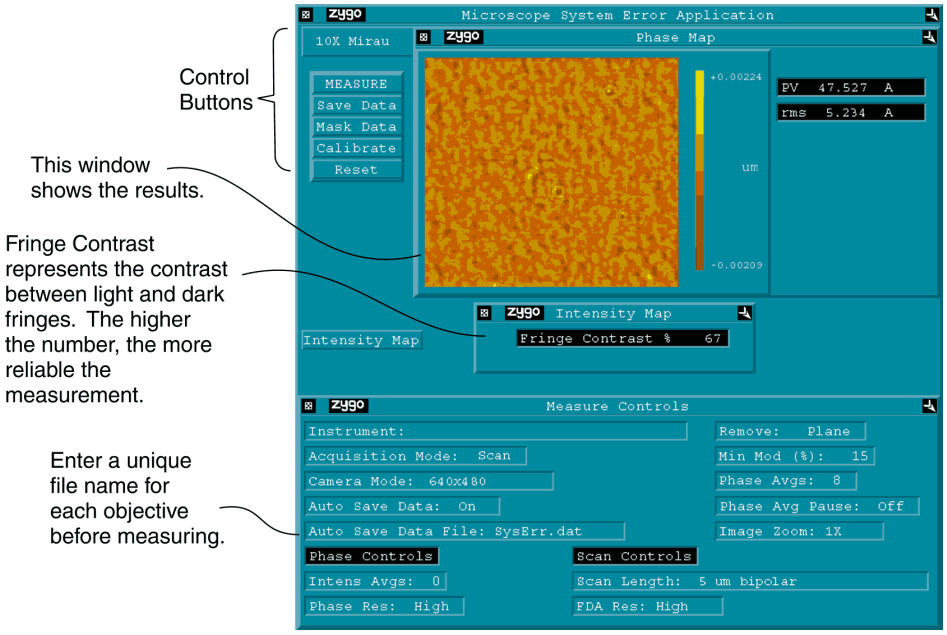
Zygo P/N: 1776-666-012
Material: Silicon Carbide
Flatness: λ/50
Roughness: ≤ 2 Angstroms rms (center 25 mm)
Individually serialized, with a test report.

Warning!
Handle the Reference Flat with care. Do not touch the reflective surface and do not attempt to clean the flat. Remove dust with a clean, filtered, dry air supply. Store inside the case when not in use.

The Microscope Error Application

To open the application, click on the MicroErr.app icon.

The Microscope Error Application Screen



Making and Using System Error Files

MetroPro has built-in capabilities to compensate for system errors by subtracting a data file made from a measurement of the Precision Reference Flat. The naming of the data files can be done manually or automatically. When the automatic mode is invoked, the software not only names the system error file during the creation phase, but also selects it to match the current objective and software settings.

It is strongly recommended to create a new error file when:

- The objective is remove and installed. This does not apply when switching objectives with the turret.
- The Image Zoom setting is changed.
- The Camera Mode control setting is changed.

Common Set-up

1. Click on the Objective button until it displays the objective in use. Make sure the Image Zoom control matches the zoom setting of the NewView.
2. Carefully remove the Precision Reference Flat from its case and place it under the objective on the stage.
3. Enter the number of averages desired in the Phase Avgs control. A rule of thumb is to use the same number of averages as used during typical measurements.
4. Position the objective at its working distance from the flat. Focus the instrument on the Reference Flat, center the darkest fringes, and null the interference pattern.
5. Proceed to either Manual or Automatic System Error File Names.

Manual System Error File Names

1. Press F5 to adjust light level; then Press F1 to measure.
2. Click the Save Data button and enter a name for the system error file. Use a name that you will recognize and indicates the objective, zoom, and camera mode, such as “10X6401X.dat”. Names must not exceed 20 characters, including the “.dat” extension.
3. Click on the Subtract Sys Err control so it says "On".
4. Click on the Sys Err File control and enter the name of the reference error file for the objective in use. Subsequent measurements will have system errors subtracted from the data.

Automatic System Error File Names

1. Click on the Subtract Sys Err control so it says "On".
2. Click on the Sys Err File control and enter the @ character.
3. Press F5 to adjust light level; then Press F1 to measure.
4. Click the Save Sys Err Data button to save the current measurement as the system error file. The software automatically generates the file name.

The @ character in the Sys Err File control activates an automatic system error file naming function for both creating and selecting the data file to subtract from measurements. The software automatically creates the system error file name when the Save Sys Err Data button is clicked. The software also automatically selects the system error file to subtract from future measurements as based on the current objective selection and the settings of the Image Zoom and Camera Mode controls. Use this function to help manage multiple system error data files.

Other Operations

Operation	How to
Save data	Click the Save Data button. In the File Handler, click the Current Selection box, enter a name for the file, ending with ".dat", and press Enter, then click Done.
Print results	Click the word "zygo" in the window you want to print or select the Print command from the window's menu. In the Print Panel, click the Print button.
Save changes made to controls, plots, results, and windows	You must save the application under a new name. Select the Save Application command from the Application Window menu. In the File Handler, click the Current Selection box, enter a name for the file, ending with ".app" and press Enter, then click Done.
Define a mask	Click the Mask Data button. Use the Mask Editor to define areas to include or exclude from the test part measurement. See "Mask Editor" in the *MetroPro Reference Guide*.
Turn off the system	**Warning!** *Improper shutdown may damage the instrument.* Select the Quit command from the MetroPro menu; turn off power after you have shut down from within Windows.

Troubleshooting

Symptom	Possible Cause and Fix
Application not functional.	MetroPro is not licensed; contact Zygo for licensing information. The hardware key or ID module is not installed. Install the hardware key and restart the computer.
No data error or graphic displays appear incomplete or with holes.	The instrument is not properly focused or the fringes are not nulled. Focus the instrument and null the fringes. The Min Mod (%) control is set too high; decrease the value. NewView scan length may be too short. Increase length with Scan length control. Improper light level. Press F4 to open the Light Level window and manually adjust the light level to maximize intensity without saturation.
Poor repeatability of results.	Improper light level. Press F4 to open the Light Level window and manually adjust the light level to maximize intensity without saturation. Parts moving during measurement. Check the support stage and fixturing. Noisy environment. Look at the video monitor for fringe drift or vibration; these signs indicate a noisy environment. Check for air drafts; ensure that the computer is not contributing noise to the vibration isolation system.
Plots appear very flat and in one color.	Improper light level. Press F4 to open the Light Level window and manually adjust the light level to maximize intensity without saturation. Spikes in data. Things to try: raise the Min Mod (%) control to try to remove poorly modulating points; turn on the Remove Spikes control; use fixed scaling in the plots to clip spikes; or use filtering controls.

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