zygo®

Corner Cube

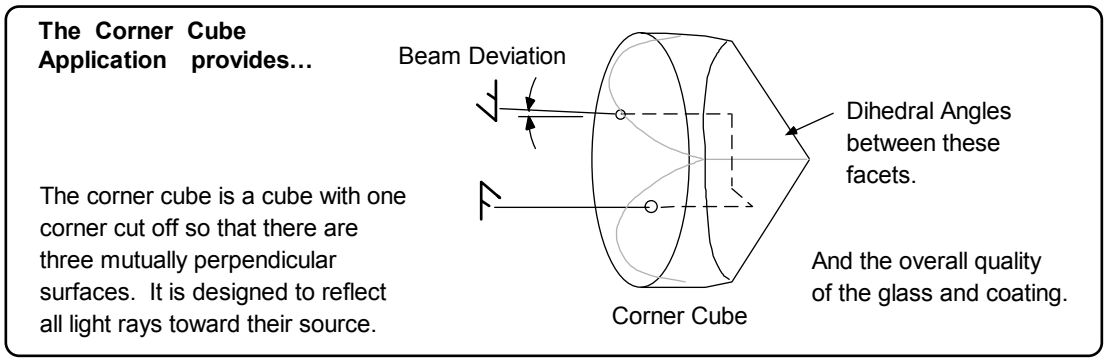
OMP-0384C

MetroPro Application

This booklet is a quick reference; it assumes that you are familiar with MetroPro software and the instrument. Information on MetroPro is provided in the *MetroPro Quick-Start Guide*, OMP-0469, and the *MetroPro Reference Guide*, OMP-0347. For information on the instrument, please refer to the Zygo Corporation manual(s) included with your instrument.

The Corner Cube Application

The MetroPro Corner Cube Application is used to measure corner cube prisms or retroreflectors. A corner cube consists of three internally reflecting facets forming 90° angles with each other. The application is designed for use with Zygo Corporation's GPI XP and the Mark IV*xp* interferometers. Any type of corner cube can be evaluated, regardless of whether it is constructed of three individual mirrored surfaces or a single piece of glass. Three categories of results are provided: dihedral angle error, beam deviation, and transmitted wavefront quality.



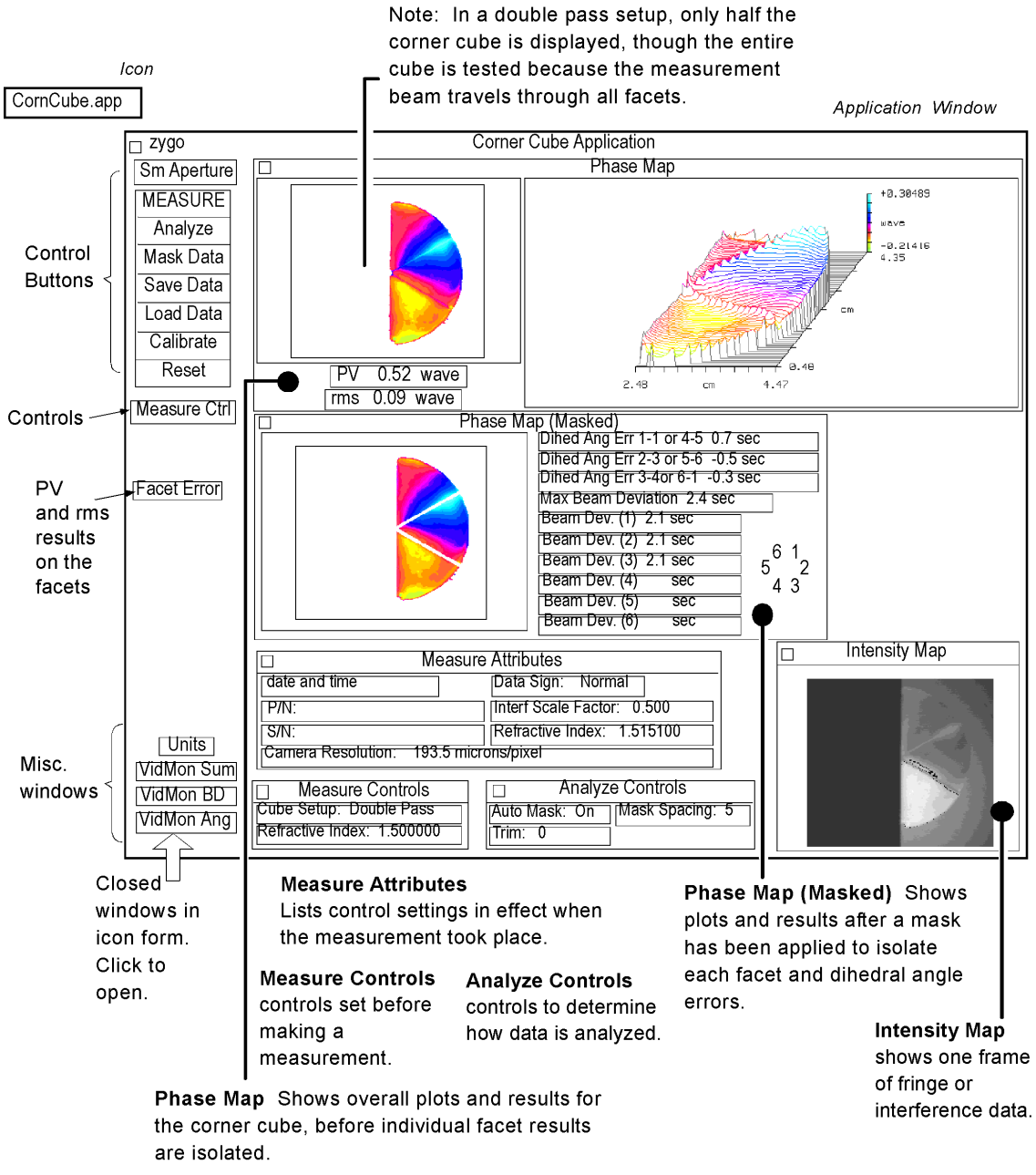
The application requires licensing to take measurements or load data. It is licensed as a separate line item in the Edit/View Licenses window. For information on licensing, see the *MetroPro Quick-Start Guide*.

The Corner Cube Application:

- Provides graphic plots and results for the entire corner cube and individual sectors.
- Supplies numerous results, including: dihedral angle error, or the deviation of the angle between the facets from 90°; beam deviation, or the deviation of the output beam from the incident beam; and wavefront quality, or the overall quality of the glass material and coatings.
- Automatically masks or selects individual sectors for isolated results.

The Application Screen

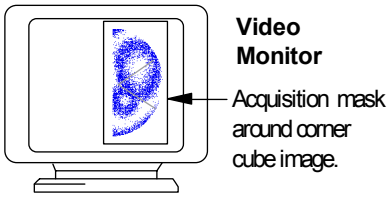
To open the application, click on the icon. If the icon is not on the MetroPro base window, then use the Load Application command from the MetroPro base window menu to first load the application icon.



Guidelines

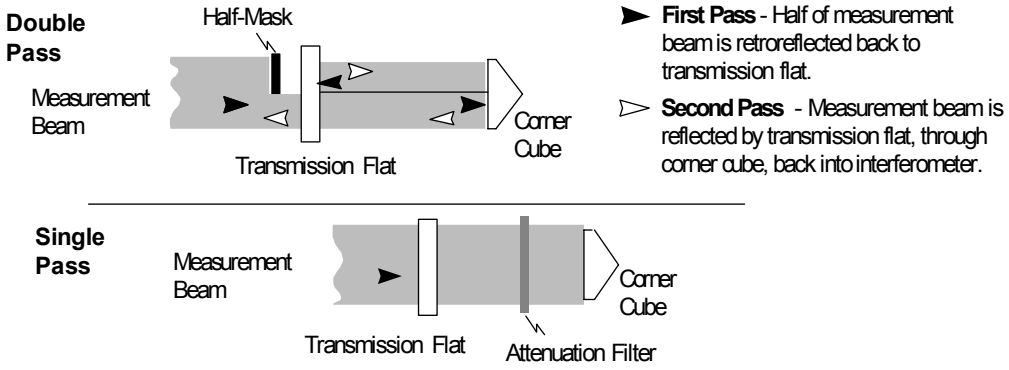
- *Hardware Requirements* - An aperture Half-Mask is required for double pass testing. An Attenuator Filter or Dynaflect™ Transmission Flat is required for single pass testing. A 2-Axis Mount with a Self Centering Element Holder may be used for holding unmounted corner cubes.

- *Use an Acquisition Mask* - Define a rectangular Acquisition mask that includes the cube, but excludes most of the background. Click the Mask Data button to open the Mask Editor. To draw the mask, click Rectangl(e), press the left mouse button and drag the cursor over the image. The move or resize buttons can be used to change the location or size of the mask. Click the BG Inc button to change it to BG Exc, so that the background is excluded. Click the Acq. button and then the Define button to define the Acquisition mask. More information is located in the *MetroPro Reference Guide*, under "Mask Editor."



- *Test Setups* - The Double Pass test is the preferred testing setup, because it is more accurate than the single pass test. In the double pass test, half the measurement beam is blocked and the remaining half is retroreflected by the corner cube twice.

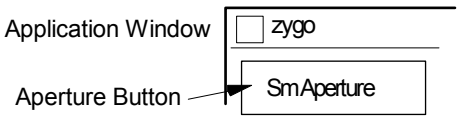
  Use the Single Pass test when measuring very small or irregularly shaped prisms. Note that in the single pass test, any asymmetrical wavefront errors introduced by the interferometer are not canceled out as they are with the double pass test. In fact, any such wavefront errors will appear to be twice as severe as they really are and will affect the measurement results accordingly.



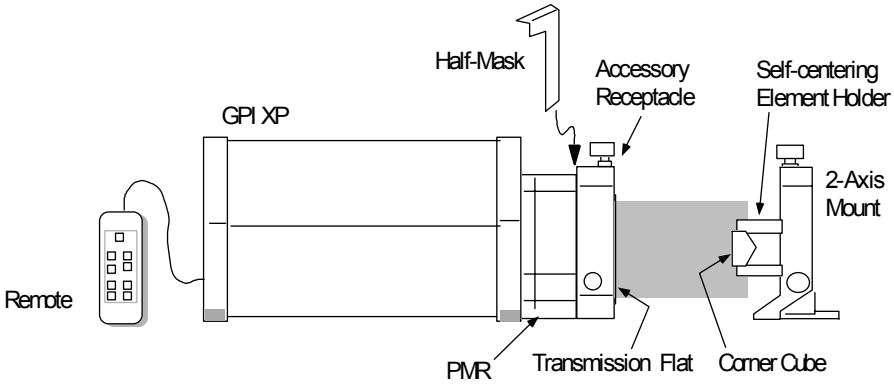
In certain measuring situations the polarization effects caused by the reflections from the corner cube faces cause low fringe contrast in some of the facets. If the fringe contrast is so low that the interferometer loses data in the double pass configuration, use single pass.

Making Measurements

1. Turn on the interferometer, start MetroPro, and open the application.

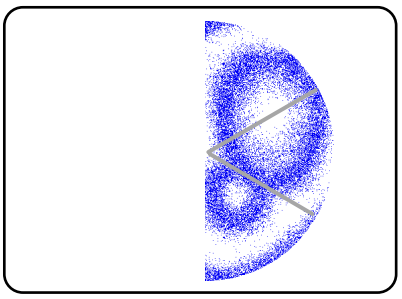


2. Click on the Aperture button until it displays the aperture in use.
3. Select the measurement type with the Cube Setup control. If the corner cube is a solid piece of glass, enter the refractive index of the material in the Refractive Index control. If the cube is constructed from three mirrored planes, enter the refractive index of air.
4. Install the Transmission Flat in the interferometer accessory receptacle and align the flat. Press the ALIGN/VIEW button on the Remote. Adjust the Tip/Tilt knobs on the accessory receptacle until the brightest spot is superimposed on the alignment crosshairs.



5. Mount the corner cube in the fixture, such that its face is parallel to the face of the Transmission Flat. Then position the corner cube in the measurement beam.
6. Single Pass Only - Place an Attenuation Filter between the Transmission Flat and the corner cube. If you are using a Dynaflect Flat, ignore this step.
7. Press the Remote ALIGN/VIEW button to switch back to the view mode. You should be able to see an image on the video monitor. Adjust the size of the image by pressing the Remote ZOOM buttons to fill as much as possible of the Video Monitor's screen.
8. Adjust the orientation of the corner cube in its mount such that one of the facet intersections and its reflection are vertical.

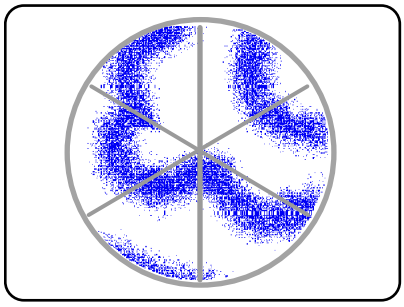
9. Double Pass Only - Insert the Half-Mask between the Accessory Receptacle and the PMR. Adjust the lateral position of the Half-Mask so that only one half of the corner cube is observed.



Double Pass Setup

Properly aligned corner cube and Half- Mask.

10. Single Pass Only - Fine-tune the tip and tilt of the Transmission Flat to obtain the best possible nulled interference pattern. It may not be possible to completely null the pattern; however, you should come as close to it as you can, making the fringes as broad as possible.



Single Pass Setup

Sample nulled fringe pattern.

11. Press the Remote FOCUS buttons to adjust the focus so that the edges of the corner cube are as sharp as possible and the ends of the fringes exhibit a minimum of bending.
12. Click the Calibrate button. Press the left mouse button and move the mouse to draw a line across the image area. The line should match up to some portion of the image for which you know the dimension. Release the mouse button and enter the dimension of the line in millimeters and then press [Enter]. Close the Calibrator window.

    Calibration is necessary for the application to calculate Dihedral Angle Error and Beam Deviation results. For more information, refer to the *MetroPro Reference Guide.*

    You must recalibrate if the zoom setting is changed.
13. Click the MEASURE button or press the F1 key.

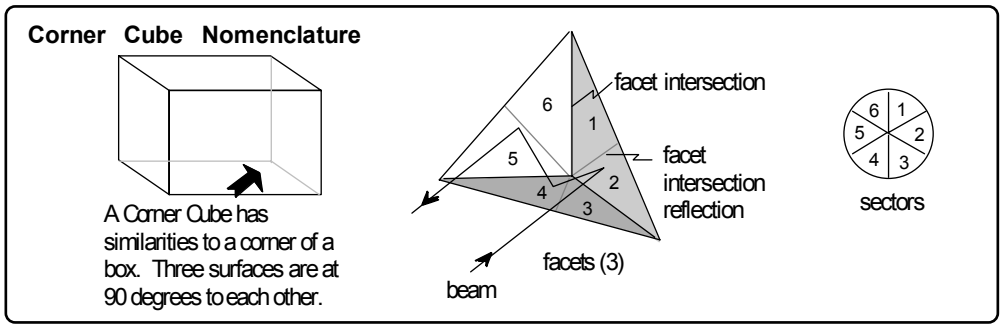
Software Controls

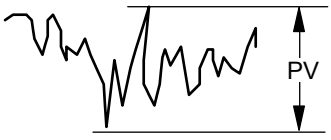
Controls of interest for the Corner Cube Application are listed. For controls not listed, or for greater detail, refer to the *MetroPro Reference Guide*.

Control	*Function*
Controls shown in Measure Controls Window	
Setup Type	Selects the test setup you are using. Settings are Double Pass or Single Pass. See "Test Setups" on page 3.
Refractive Index	Specifies the refractive index of the corner cube material, if the corner cube is a solid piece of glass. If the cube is constructed from three mirrored planes, enter the refractive index of air. For example, the Refractive Index for BK-7 is 1.51633; the refractive index of air at STP is 1.0002714.
Controls shown in Analyze Controls Window	
Auto Mask	When On, a mask is automatically created that surrounds each corner cube sector. It is used to isolate the sectors for results on each individual sector. When Off, individual sector results are not calculated.
Mask Spacing	The width in camera pixels of space between the adjacent mask figures created by the Auto Mask feature. The spaces between masks are necessary to eliminate facet intersections and their reflections from the analysis.
Trim	Specifies the number of pixel layers to remove from edges of the data.
Controls in Measure Ctrl icon	
Intens Avgs	Specifies the number of intensity averages to perform during measurements to improve repeatability. The default setting is 0.
Phase Avgs	Specifies the number of phase averages to perform during measurements to improve repeatability. The default setting is 0.
Phase Res	Selects the resolution of the phase computation. Settings are Normal, High, or High X. Should be set to Normal.
Remove Tilt Bias	Eliminates the addition of tilt in the phase data caused by the PZT's movement. Must be On for double pass setups.
Min Mod (%)	Specifies 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.

Corner Cube Results

Refer to the drawing below and the accompanying table for an explanation of Corner Cube results.



Result	*Description*
Beam Dev. (1)…(6)	Individual beam deviation results for each of the six sectors. Results for all six are displayed when using the single pass setup. With double pass setups, beam deviations for sectors 4, 5, and 6 are not shown as they duplicate the results for sectors 1, 2, and 3.
Dihed Ang Err 1-2 or 4-5 **Dihed Ang Err 2-3 or 5-6** **Dihed Ang Err 3-4 or 6-1**	The amount that the named facets deviate from being truly perpendicular to one another. The numbers refer to intersections of sectors, for example: 1-2 refers to the intersection of sectors 1 and 2. A positive number indicates that the dihedral angle is greater than 90 degrees, a negative value denotes less than 90 degrees.
Max Beam Deviation	Beam deviation is the angle that a retroreflected ray of light deviates from being parallel to the incident ray of light. This result displays the maximum of the individual sector results.
Peak (1)…(6) **(All)**	The highest point of each of the six sectors when using a single pass setup, or only sectors 1 through 3 when using the double pass setup. All refers to all sectors together.
Pts in PV Spec (1)…(6) (%)	The percentage of valid data points within a user specified high limit for each of the PV (1)…(6) results. Each is linked to the matching PV result and displays a percentage result only if a high limit is set on the PV result. When a percentage is displayed, it represents the percentage of data points within the set limit.
PV	The height between the lowest and the highest point on the corner cube surface. 
PV (1)…(6) **(All)**	The transmitted wavefront peak-to-valley of each of the six sectors when using a single pass setup, or only sectors 1 through 3 when using the double pass setup. All refers to all sectors together.

Corner Cube Results (continued)

Result	*Description*
rms	The root-mean-square deviation of all points from a plane fit to the corner cube surface. 
rms (1)…(6) (All)	The transmitted wavefront root-mean-square of each of the six sectors when using a single pass setup, or only sectors 1 through 3 when using the double pass setup. All refers to all sectors together.
Tilt X (1)…(6)	The tilt in the x-axis for each of the six sectors when using a single pass setup, or only sectors 1 through 3 when using the double pass setup.
Tilt Y (1)…(6)	The tilt in the y-axis for each of the six sectors when using a single pass setup, or only sectors 1 through 3 when using the double pass setup.
TltAng (1)…(6)	The direction of tilt for each of the six sectors when using a single pass setup, or only sectors 1 through 3 when using the double pass setup.
TltMag (1)…(6)	The overall tilt for each of the six sectors when using a single pass setup, or only sectors 1 through 3 when using the double pass setup.
Valley (1)…(6) (All)	The lowest point of each of the six sectors when using a single pass setup, or only sectors 1 through 3 when using the double pass setup. All refers to all sectors together.

Other Operations

Operation	*How to*
Save data	Click the Save Data button. In the File Handler, enter a name for the file, ending with ".dat", and press [Enter]. Then click the Done button.
Print	Click the word "zygo" in the window you want to print or select the Print command from the window's menu.
Saving 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, enter a name for the file, ending with ".app", and press [Enter]. Then click the Done button.
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. The application is licensed as part of standard MetroPro; contact Zygo Corporation 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.
Poor repeatability of results.	Parts moving during measurement. Check part 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.

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