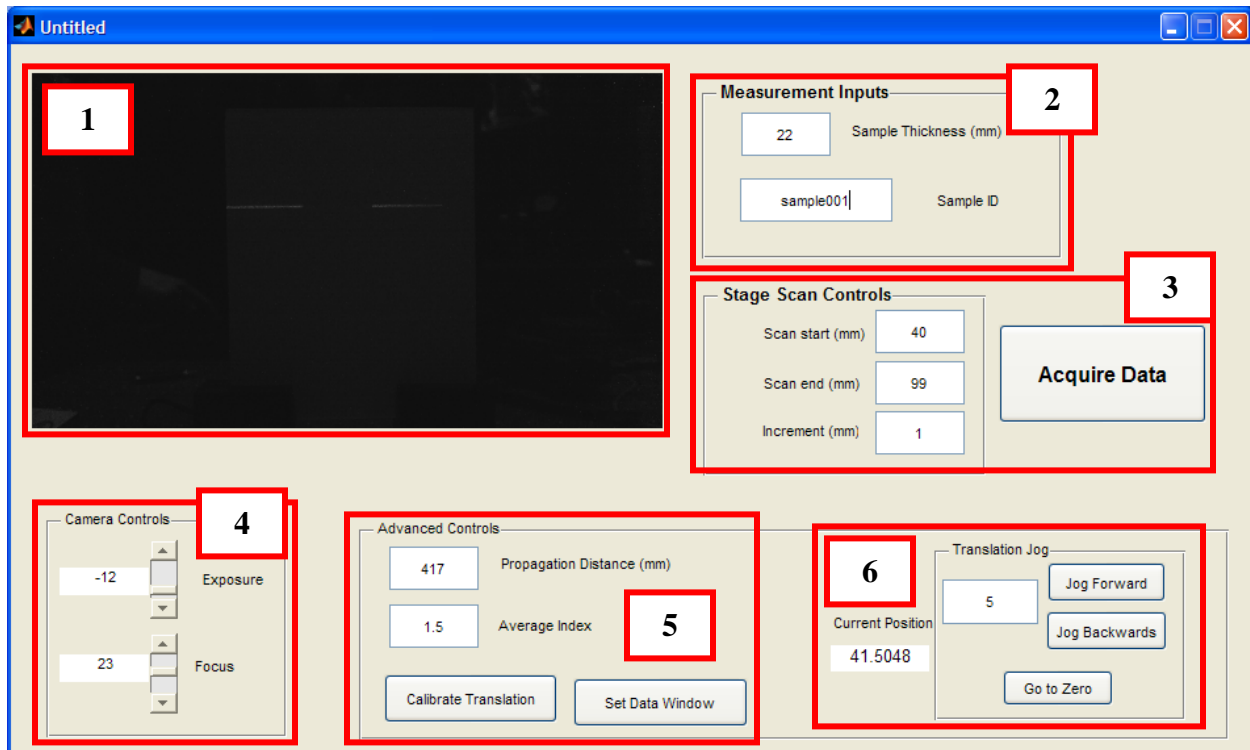


Deflectometer Manual and Operating Procedure

Last Revised March 6, 2013 by:
Peter McCarthy
University of Rochester

GUI Functions



1. Live video feed
 - Shows camera view of diffuser screen
 - Used to ensure Exposure and Focus controls are at appropriate values
 - Used with “Set Data Window” advanced control
2. Measurement Inputs
 - Sample Thickness – measure sample thickness (in mm) in the direction the laser is propagating
 - Sample ID – input sample ID. This is used, along with the date of the measurement, to label the file when data is exported.
 - o If multiple measurements are taken with the same Sample ID on the same day, only the last measurement is saved. You must manually rename the file for the previous measurement to avoid the file being overwritten.
3. Stage Scan Controls
 - Defines the region of the sample to scan
 - Scan start – defines the endpoint at the top of the sample
 - Scan end – defines the endpoint at the bottom of the sample
 - Increment – the stage will scan from “Scan start” to “Scan end” with this increment.
 - o 0.25mm is the smallest increment recommended
 - o Larger increment values will result in faster scans but lower accuracy.
 - Acquire Data – when all of the parameters for the measurement have been set, this button begins the measurement and exports the data to a Microsoft Excel file

4. Camera Controls

- These parameters only need to be changed if the setup has been changed from the initial installation.
- Exposure – adjust exposure level so that the laser is not saturating the detector. Use live video to help with adjustment.
- Focus – adjust focus to bring the diffusing screen into focus. It can be helpful to temporarily increase the exposure (after turning off or blocking the laser beam) and place a piece of paper with text against the back surface of the diffuser. Then adjust the focus control until the image of the text is sharp.

5. Advanced Controls

- These parameters only need to be changed if the setup has been changed from the initial installation.
- Propagation Distance – the distance from the back surface of the sample to the first surface of the diffusing screen.
 - o This parameter should not change if samples of the same diameter are mounted in the same position for each measurement.
 - o If sample diameter is changing drastically or if the sample position is changing then this should be measured and updated for each measurement.
- Average Index – this input is not used in the current version of the software. It is reserved for improved reconstruction algorithms in future software updates.
- Calibrate Translation – this button calibrates the pixel position of the camera to a physical distance.
 - o This option should be run if the setup is changed from the original installation.
 - o Run if the distance from the diffusing screen to the camera is changed or if the camera is bumped, nudged, or readjusted.
- Set Data Window – this input tells the software what part of the laser line passed through the sample and what part did not.
 - o Does not need to be changed if samples are mounted in the same position as the original installation.
 - o If the sample position moves or if the camera moves then this should be run before any data is taken.

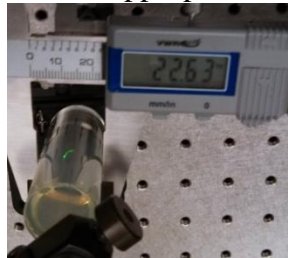
6. Advanced Controls – Translation Jog – used to manually move the translation stage with laser beam

- Current position – shows the current position of the translation stage (in mm)
- Translation Jog numerical input – controls how far the stage is moved (in mm) when the “Jog Forward” and “Jog Backwards” buttons are pressed.
 - o Jog increments smaller than 1mm may not register when the jog buttons are pressed
- Jog Forward / Jog Backwards – moves the stage forward (toward the bottom of the sample) or backwards (toward the top of the sample) by the specified distance
- Go to zero – retracts the translation stage to its most compact position
- The jog controls are used to determine the “Scan start” and “Scan end” controls.

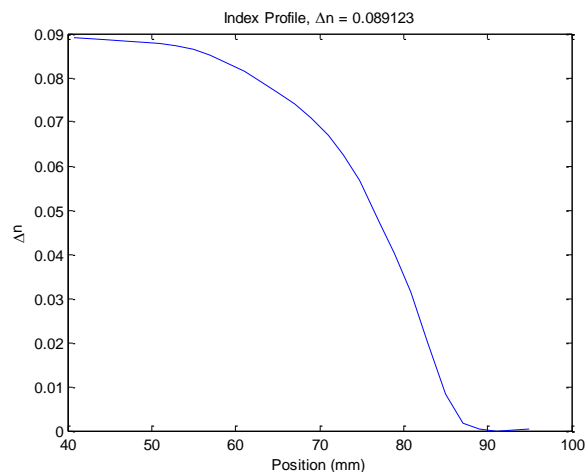
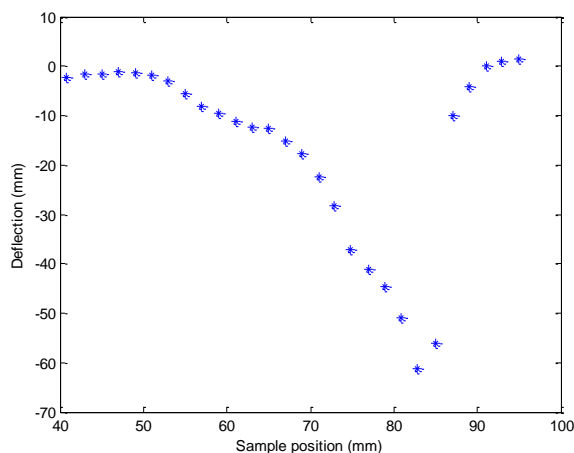
Measurement Procedure

This section details the procedures for measuring a sample assuming none of the advanced controls need to be changed and the instrument has not been altered from the condition in which it was installed. For advanced settings, see the next section.

1. Ensure the USB cables for the stage and the camera are plugged into the computer before the software is started. If the software gives you an error when it starts, please close the program, check that the USB cables are plugged in, and restart the software.
2. Turn on the laser. Allow several minutes for the laser to warm up and stabilize.
3. Measure thickness of sample and enter in appropriate GUI input.



4. Input sample ID.
5. Mount sample in sample holder. If mounted in the same position as previous samples, the tilt of the sample should not need to be adjusted and the “Propagation Distance” should not need to be changed.
6. Check stage scan controls. If the “Scan start” and “Scan end” values are not appropriate for your sample, use the “Translation Jog” controls to determine the correct scan range. Choose an appropriate increment for the scan.
7. Press “Acquire Data”. The laser will scan across the sample until all of the data is collected. Then, the data will be processed and plots of the deflection and the index profile will be created, as shown below.

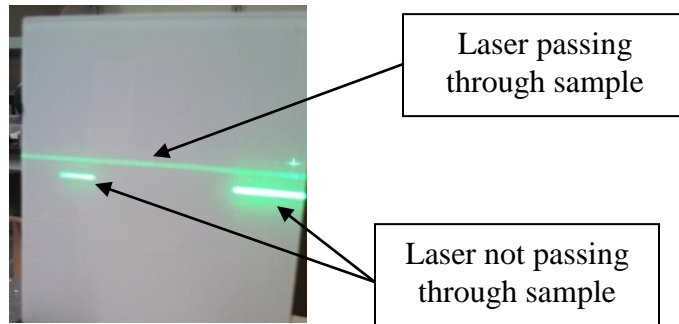


8. View exported data. The data is saved as a Microsoft Excel file with the filename “Date_SampleID”, where “Date” is the date of the measurement (eg 2013_Mar_06) and “SampleID” is the value used in Step 4. The file contains the index profile and deflection data as a function of position, as well as the sample thickness and propagation distance.

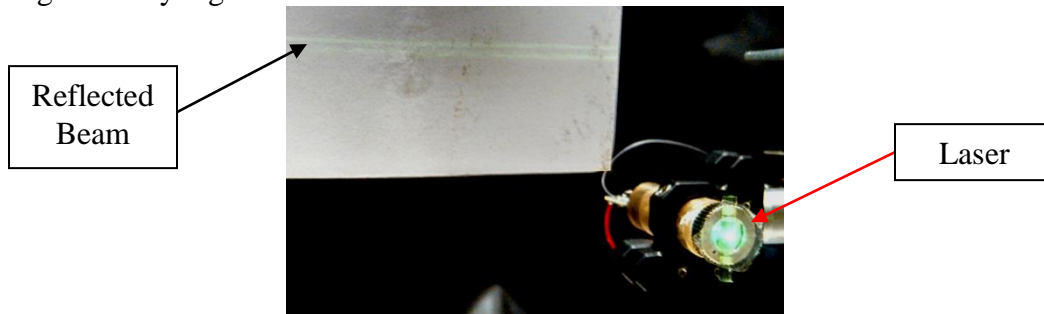
Advanced Settings

Sample Alignment

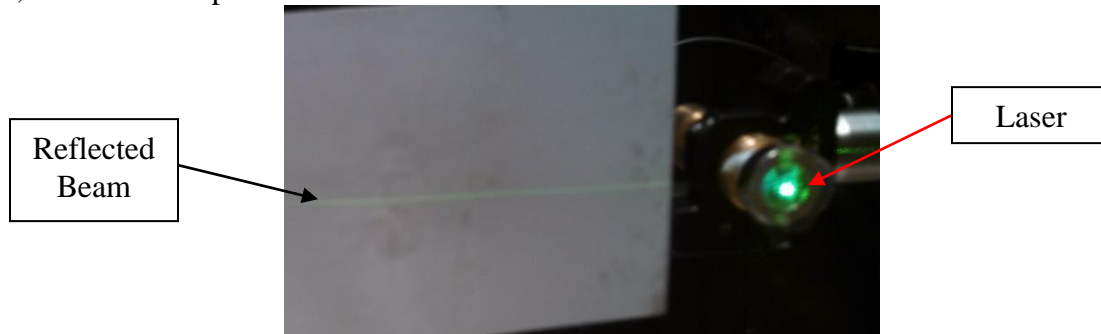
The sample should be positioned such that it is centered in the diffusing screen. On the diffusing screen you should see two portions of the laser line that did not pass through the sample and a gap in the middle where you see the portion of the laser that does pass through the sample.



The tilt of the sample is also important. The axis of tilt that tilts the sample toward and away from the diffusing screen is aligned by looking at the laser beam as it is reflected off of the sample back toward the laser. The picture below shows a misaligned sample where the reflected beam is significantly higher than the laser.

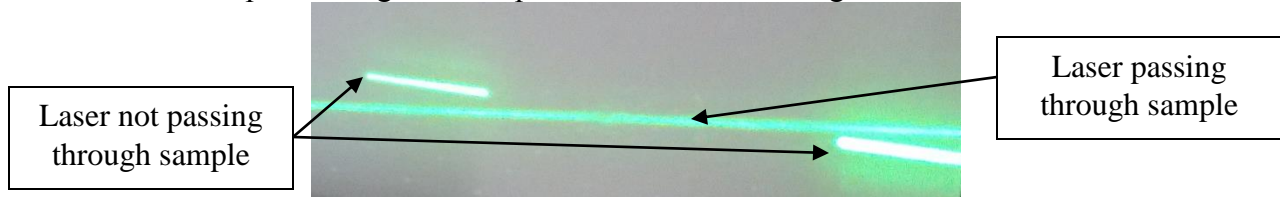


Adjust the tilt of the sample mount until the reflected laser beam is at the same height as the laser, as seen in the picture below.

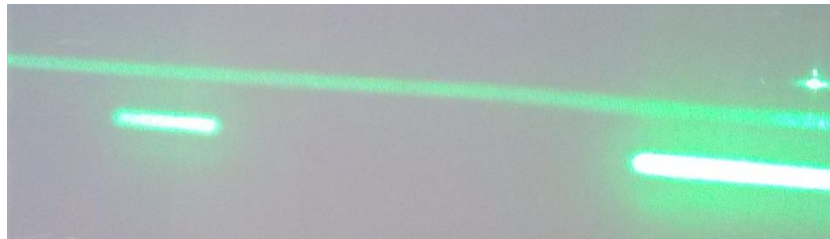


The other axis of tilt is adjusted by looking at the laser line on the diffusing screen. It is easiest to make this adjustment when the beam is passing through a homogeneous region of the sample.

When the sample is misaligned, the beam passing through the sample will not be parallel to the beam that doesn't pass through the sample. This is seen in the figure below.

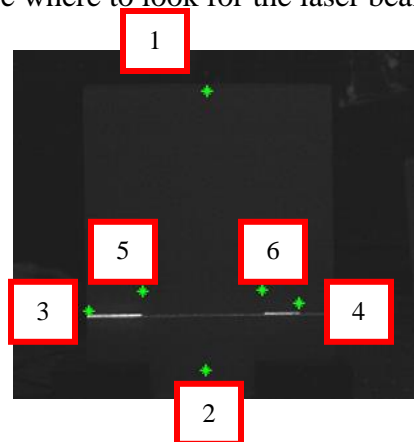


Adjust the other axis of tilt on the sample mount until these two lines are parallel, as seen below. This figure shows a case where the beam is passing through the GRIN region of the sample. The two lines are still parallel, but they are displaced from each other due to the laser light bending in the GRIN material.



Set Data Window

The “Set Data Window” button tells the software which part of the camera video to analyze. This button should be used if the camera is moved or if the sample is moved relative to its original position when the instrument was installed. When the software is loaded, it loads the default data window, which was set upon installation. When the button is clicked, you will be prompted to click certain areas on the live video screen. The areas to be clicked are: (1) top of the diffuser screen, (2) bottom of the diffuser screen, (3) left edge of the diffuser screen, (4) right edge of the diffuser screen, (5) left edge of the sample shadow, and (6) right edge of the sample shadow. These six points tell the software where to look for the laser beam. They are indicated on the figure below.



Calibrate Translation

Images taken with the camera need to be calibrated so that a pixel position in the image can be correlated to a physical distance on the diffusing screen. The instrument was calibrated upon

installation, but if the camera is moved relative to the diffusing screen it will need to be recalibrated. To perform calibration, remove the sample and the sample mount from the beam path so that the laser is unobstructed on its path to the diffusing screen. Use the “Set Data Window” function to indicate the extent of the diffusing screen (the 5th and 6th points aren’t critical for this calibration, so they can be placed approximately where they would be if a sample was in the beam path). Then, press the “Calibrate Translation” button. This will make the translation stage move in small increments while the beam is tracked on the diffusing screen. Once the calibration is complete, the sample mount and sample can be replaced. The “Set Data Window” function should be used again so that the sample shadow is accurately known. The instrument is now ready to be used.

Propagation Distance

If the distance from the rear surface of the sample to the diffuser screen is different than the original installation, the “Propagation Distance” parameter needs to be updated. Measure the distance using a ruler or other device and input the number in the appropriate box in the GUI.

