

E X I C O R[®] GEN5

BIREFRINGENCE MEASUREMENT SYSTEM

USER MANUAL

Hinds Instruments, Inc.
P/N: 010-0000-061 UM Rev B

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P/N: 010-0000-061 UM Rev B

Software 025-0000-066 Version 1.0

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Operators' Safety Summary

The general safety information in this summary is for operators of the Exicor Birefringence Measurement System. Specific warnings and cautions may be found throughout the manual where they apply, but may not appear in this summary.

Terms

DANGER statements identify conditions or practices that will result in personal injury or loss of life.

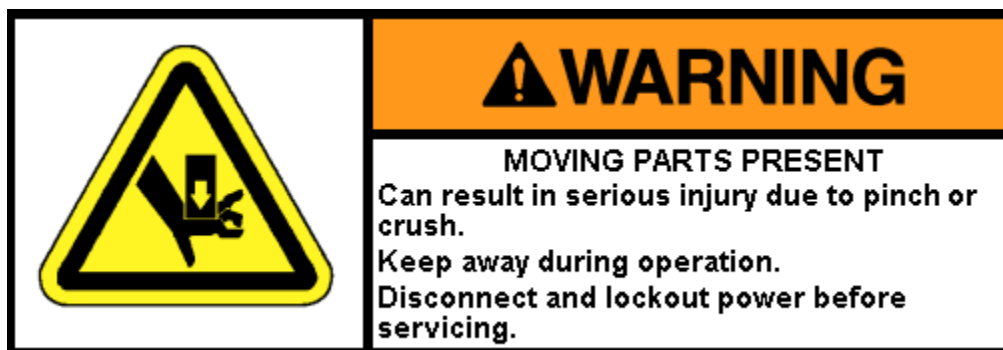
WARNING statements identify conditions or practices that could result in personal injury or loss of life.

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

NOTICE statements identify conditions or practices that are important in proper use of the equipment to get the expected results.

Labels

The label below is placed on the front of the system, the rear of the system, and on the sides of the gantry. See #1 in Figure S.1 and Figure S 3.



P/N 095-2600-011

The wording on this label is:

Warning, Moving Parts Present. Can result in serious injury due to pinch or crush. Keep away during operation. Disconnect and lockout power before servicing.

The pinch point hazards on the system are marked with the following label and with hazard warning tape. The main pinch points are at the motor side of each actuator, the area on the tilt slide where the detector module passes underneath, and the rear of the sample holder where the detector cable mount passes underneath. See #2 in Figure S.1.



The wording on this label is:

Caution pinch point.

The following IEC/EN Logotype label is placed on the sample locating corner. See #3 in Figure S.2.



The wording on this label is:

Caution. Laser light. Avoid direct eye exposure. 5 mW at 633 nm. CDRH class IIIa laser product. IEC/EN class 3R laser product.

The Source Module and Detector Module are marked with the following Protective Housing label on the covers and inside the modules. See #4 in Figure S.2.



The wording on the label is:

Caution. Class 3R laser light when open. Avoid direct eye exposure.

The Source Module is marked with the following Laser Light label near the aperture. See #5 in Figure S.2.



The wording on the label is:

Avoid Exposure. Laser light is emitted from this aperture.

The label below is placed near the rear of the control system. See #6 in Figure S.4.



The wording on the label is:

Warning. Hazardous voltage. Contact may cause severe shock or burn. Disconnect and lockout power before servicing.

The system identification label below is placed on the rear of the Scanning Module. See #7 in Figure S.3.



The wording on this label is:

Model No. _____, Serial No. _____, Manufactured: _____.

The following figures show the system with the Sample Holder Tilt option. If your system does not have this option, some of the pinch points shown below will not apply.

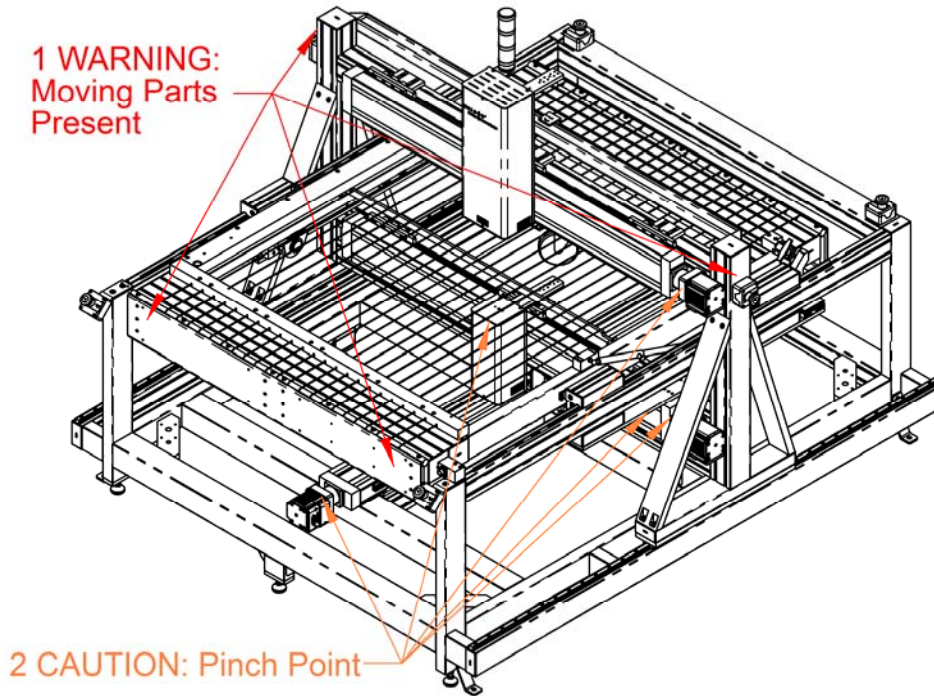


Figure S.1 Compliance Labeling - Mechanical

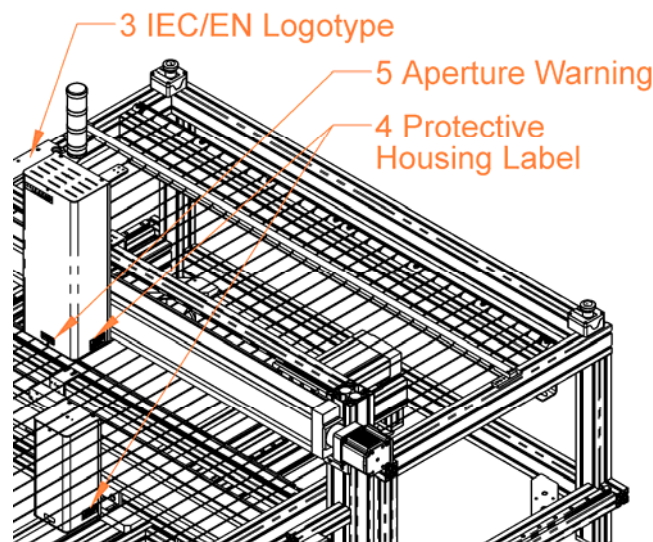


Figure S.2 Compliance Labeling – Laser

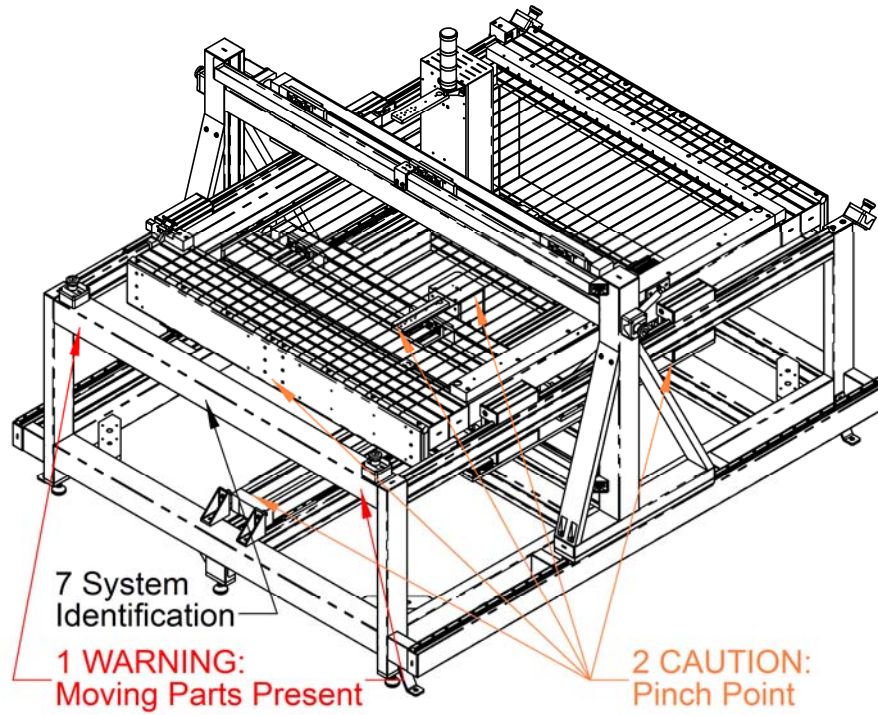


Figure S 3 Compliance Labeling – Rear

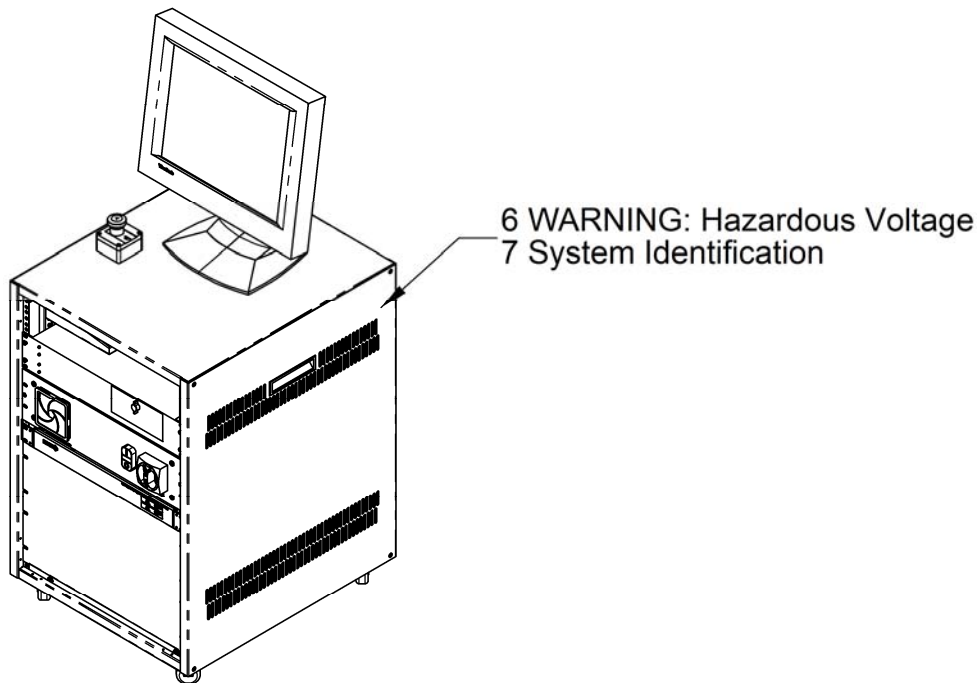


Figure S.4 Compliance Labeling - Control System

Power Source

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either the supply conductor and ground. A protective ground connection by way of the grounding connector in the power cord is essential for safe operation. The user should supply power to the system that will provide at least the following amount of current at the corresponding supply voltage:

115/220VAC ~, 9/4A, 50/60Hz

Use the Proper Power Cord

Use only the power cord and connector that was provided by Hinds Instruments during delivery of the system. This cord is hard-wired to the system and can only be changed by Hinds Instruments personnel.

Do Not Operate without Covers

To avoid personal injury, only operate this product with all covers or panels installed.

Light Safety

The light source contained in the Source Module is a low power (CDRH Class IIIa, IEC Class 3R) Helium-Neon laser.

The laser is a fixed output device. No adjustments are possible.

The output from the Source Module, after attenuation by the polarizer and the PEM, is typically less than 3.2 mW.

The maximum power output directly from the laser, between the laser and the first optical element, is 5 mW at 633 nm.

2 to 5 mW levels of output power are to be found from the "laser pointers" used by lecturers and from a variety of surveying and construction instruments.

CAUTION

Avoid direct eye exposure to the beam and to reflections from shiny objects.

This or any other low power laser can cause a temporary inability to see clearly, much as is experienced by exposure to the flash of a camera.

Use of controls or adjustments or performance of procedures other than those specified herein, may result in hazardous laser light exposure.

Persons other than qualified maintenance personnel should not unnecessarily remove covers.

See Laser Safety labels on pages 2 and 3.

Studies of the safe level of exposure to low power lasers can be found in:

- Standard for the Safe Use of Lasers, ANSI Z136.1, Laser Institute of America, 407/380/1553.
- Ocular Damage Thresholds for the Helium-Neon Laser, Arch. Environ. Health, Vol. 20, Feb. 1970, Lt Col Paul W. Lappin, BSC, USAF, Brooks Air Force Base, Texas.
- Laser Pointers and the Human Eye – A Clinicopathological Study, Arch. Ophthalmol, Vol. 118, Dec. 2000, Dennis M. Robertson, MD, et al., Dept. of Ophthalmology, Mayo Clinic, Rochester, Minn.

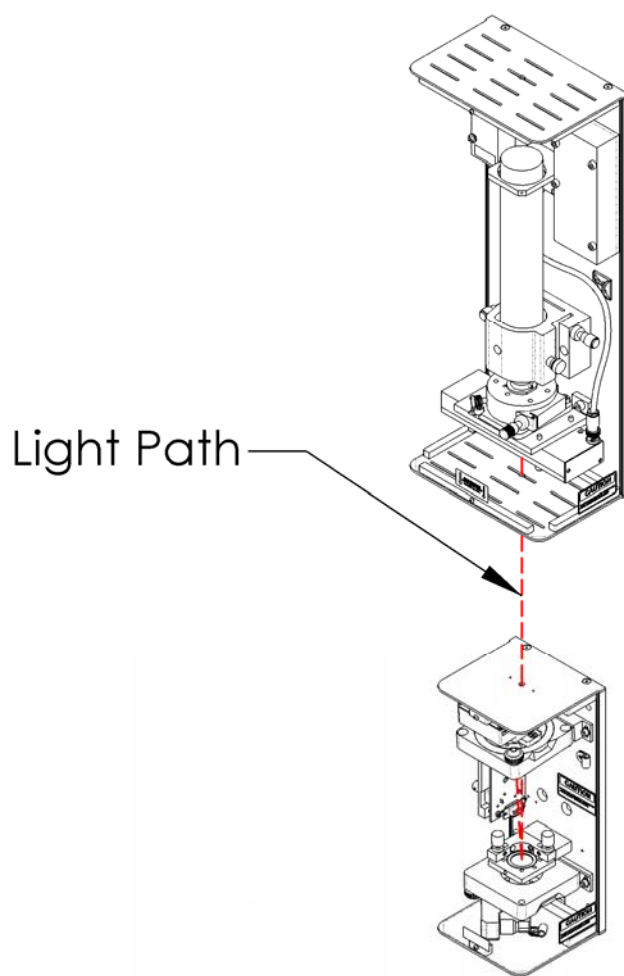


Figure S.5 Light Path

Emergency OFF Switch

The Exicor GEN5 has 7 Emergency OFF (EMO) switches. Each switch consists of a large red button on a yellow background. These switches disconnect power to all system components except the computer and monitor. Figure S.6 shows the location of the Emergency OFF switches.

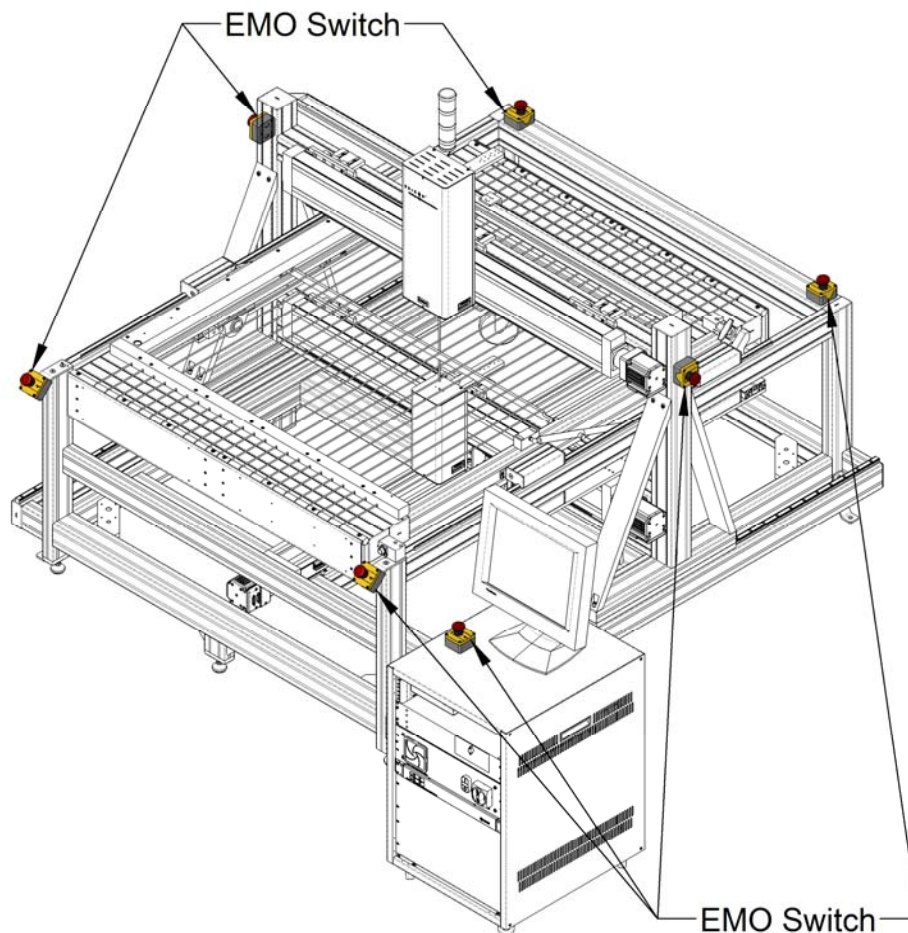


Figure S.6 EMO Switch Locations

Activating the EMO System

In the event that an unsafe event or condition is observed with the system, an EMO switch should be activated by pushing or slapping the red button. Pressing any EMO button will remove power to all system components of the Sample Scanning Module. Activating the EMO system will not harm the Exicor GEN5.

Activating the EMO system **will not** remove power to the Exicor GEN5 PC, monitor, or third party equipment located at the user station. The power cord acts as the emergency disconnect device for the computer and monitor.

Data collected prior to the activation of the EMO system will not be lost, however any scan running will be stopped when the EMO button is pushed.

NOTICE

If an unsafe condition is observed at the User station, the user should remove power to the components in question by unplugging the power cord from the power outlet.

Power should not be restored to the components or system until the unsafe condition is corrected.

Recovering From an EMO Activation

Before attempting to restart the Exicor GEN5, first clear the condition that prompted the EMO button to be pushed. Once the condition is made safe for the user and equipment, the EMO button should be pulled out.

Pulling the EMO button out **will not restart the system**. After the EMO button is pulled out, the Exicor GEN5 can be reactivated by pressing the green 'ON' button on the main power switch box (see Figure 1.2).

Once power is restored to the Exicor system, the software will need to be restarted or the 'Home and Reset' button on the UI will need to be clicked.

NOTICE

The Exicor GEN5 will not turn ON until all EMO buttons are pulled to the 'OUT' position.

If the Exicor GEN5 system will not turn ON after an EMO event, check that all EMO buttons are pulled out.

If the system still will not turn ON, contact Hinds Instruments.

Mechanical Safety

WARNING – PINCH/CRUSH HAZARDS

Keep clear of the system while it is scanning to avoid harm due to pinch points. Failure to keep away from the system during motion can result in serious injuries to hands and fingers.

The Exicor GEN5 system has an open frame construction. As a result, there are significant mechanical hazards that the operator should avoid. When power is ON, keep your arms and hands away from the source and detector modules, the actuators, their guide tracks, and nearby frame pieces. Major hazard locations have been marked with warning labels to indicate the most hazardous areas of the system. Review the compliance labeling drawings above before operating the system.

Actuator motion occurs during sample scanning and during software startup. Turn OFF power to the Exicor GEN5 when making changes to the sample holder or when servicing the system.

Electrical Safety

Rear panel outlets, other than AC outlets, carry low voltage signals and controls. Typical voltages are 0 to 4 volts with none exceeding 24 volts.

The Exicor GEN5 contains no user-serviceable components. Refer any maintenance or adjustment needs to Hinds Instruments, Inc.

Do not allow any liquids to get inside the equipment.

Maintenance of the other elements of the system should be referred to Hinds Instruments, Inc. or other trained personnel.

Overview of the Exicor GEN5 Birefringence Measurement System

The Exicor GEN5 Birefringence Measurement System is an easy-to-use highly sensitive instrument for measuring the magnitude and fast axis of linear birefringence in optical materials. The system allows the user to run an area scan of a flat transmissive sample and create a birefringence map of the sample.

Exicor GEN5 Birefringence Measurement System Description

Listed below are the main components of the Exicor GEN5 Birefringence Measurement System.

Sample Scanning Module: Includes the components for generating the modulated beam of light and detecting the light as it exits the sample. See Figure 1.1 on the following page for the component layout. The individual components are:

- **Source Module**
 - He-Ne Laser – provides 633nm light beam.
 - 50 kHz PEM – Provides controlled modulation of the beam polarization state before the sample.
- **Detector Module** – Det-92 detectors acquire the modulated laser beam after it has passed through all polarization optics. Signals from the detector are used to determine the birefringence of the sample.
- **X-Y Actuators** – Provide a means of moving the source and detector modules so that the light beam passes through the sample at different points.

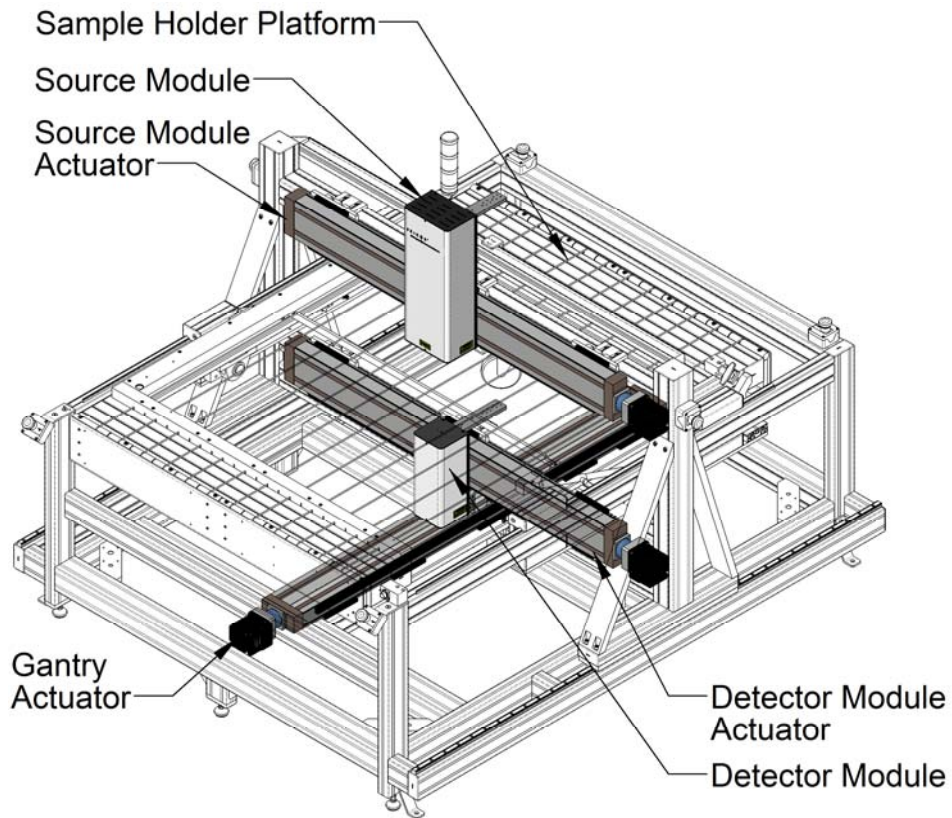


Figure 1.1 Scanning Module Main Components

Control System: Controls and supplies power to all the hardware required for sample scanning and birefringence measurement. See Figure 1.2 for the component layout. The components of the Control System are:

- **Master Electrical Enclosure** – Houses all power supplies and control electronics necessary for safe and efficient system operation.
- **Signaloc™ Lock In Amplifiers (LIA)** – Demodulate the detector signal with very high sensitivity and low noise. After demodulating the signal, the LIAs digitize and send the detector signal characteristics to the computer.
- **Computer and Exicor software** – Controls the movement of the source and detector modules during testing, calculates the birefringence at each measurement point, maps the birefringence of the sample, and stores the sample data.

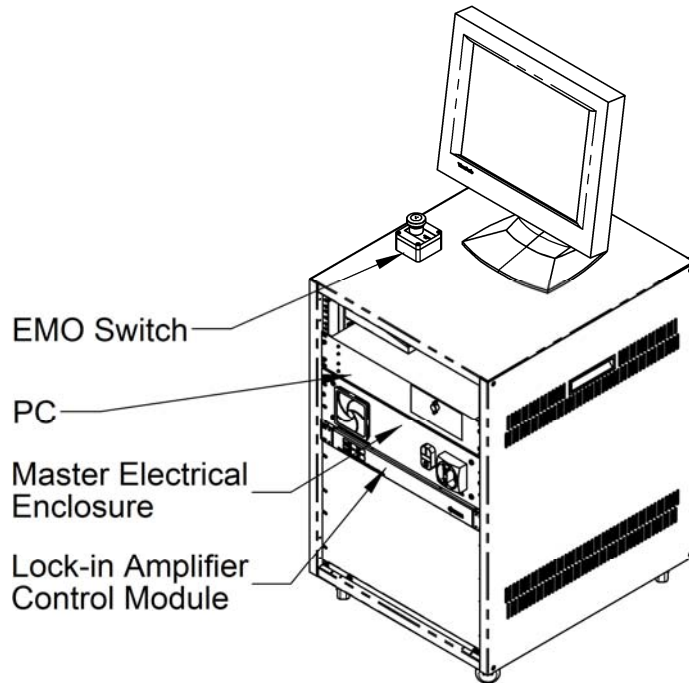


Figure 1.2 Control System Main Components

General Dimensions

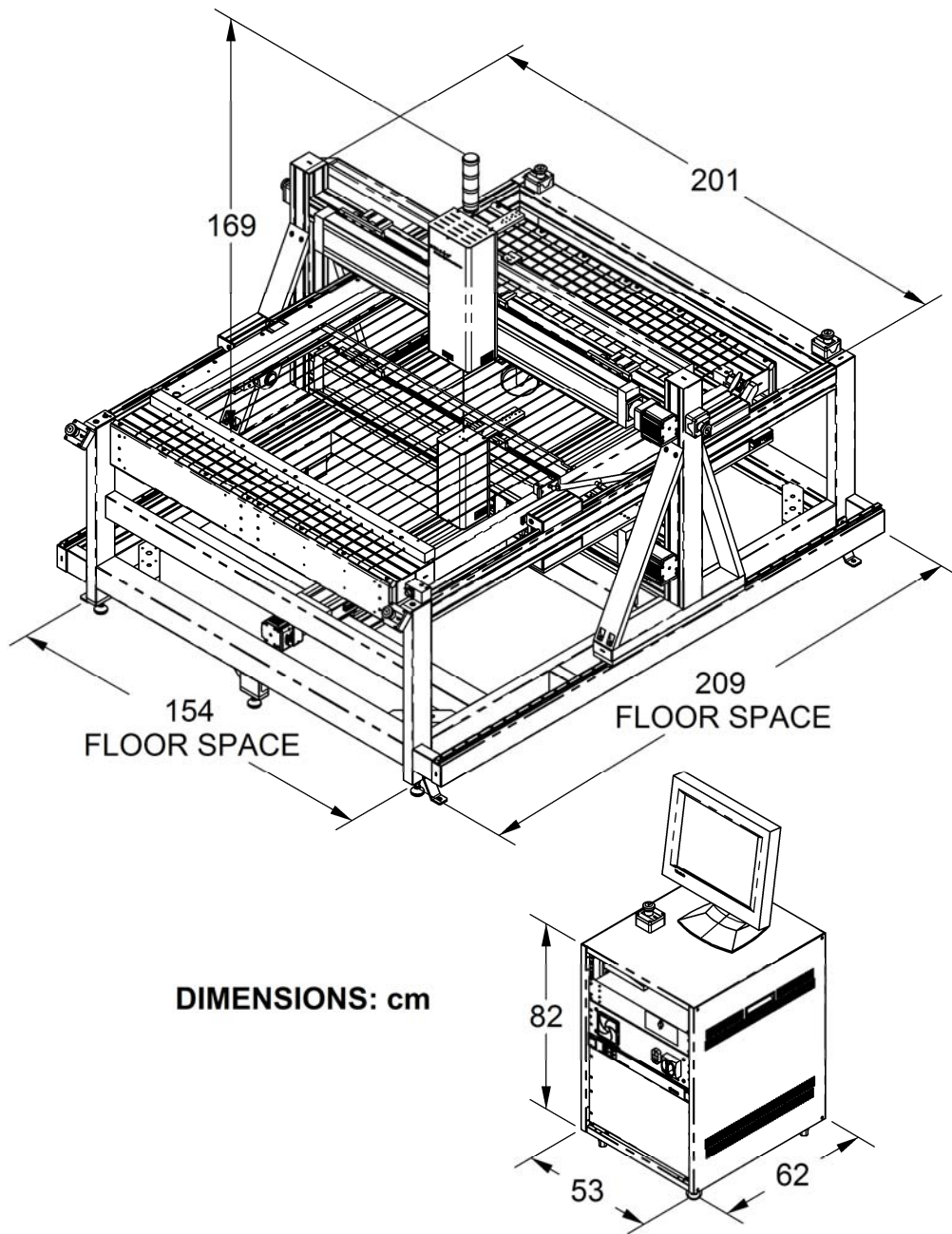


Figure 1.3 General Dimensions

2

System Operating Requirements/Setup

Operating Configuration

The control system needs to be placed nearby the sample scanning module to facilitate connection of all hardware control cables. It can be placed near the rear or the front of the scanning module.

The control system is configured from the factory to act as a user station. The computer monitor can be placed on its top and it includes a retractable keyboard and mouse drawer.

Power Connections

The Exicor GEN5 system is designed for operation at 100-240VAC, 50/60 Hz. Components within the system have been set for the customer's native voltage prior to shipment. User adjustment should not be necessary.

The Exicor GEN5 control system requires a single power outlet. The computer and monitor are powered from a power strip inside the control system.

Proper System Airflow

Airflow in the Control System enters through a filter element at the front panel and exits through the rear panel. The airflow helps maintain a lower ambient temperature inside the case, extending the life of the interior components. The control system must be set up in a location so that the airflow into and out of the system is not restricted.

The control system should be oriented so that heat from the rear panel is not directed at the sample holder.

Turning the Exicor GEN5 On and Off

The main power switch for the Exicor GEN5 is located on the front panel of the control system. Rotating the switch to the ON position will allow AC power from the wall to enter the Master Electrical Enclosure (MEE).

Once the main power switch is in the ON position, start the system by pushing the green button on the front of the control system; this will power up all system devices. To turn the system OFF, simply push the red button on the Start/Stop switch. If the system will not be used for an extended period of time, rotate the main power switch to the OFF position.

Exicor software

The Exicor GEN5 Birefringence Measurement System was delivered with the software application installed.

Note: All systems sold by Hinds Instruments are currently installed and supported only through Hinds Instruments, Inc. and authorized dealers.

Calibration

The Exicor GEN5 has been calibrated by Hinds Instruments, Inc. prior to shipment. The instrument should require no mechanical or optical adjustment for most applications. Regularly performing an air offset (“zeroing” the system) will ensure optimum low level sensitivity.

3

Operating The System

WARNING

The Exicor GEN5 Birefringence Measurement System contains hazards such as: uses visible light, has potential pinch points, and is operated at normal line voltage.

All operators should be aware of the Main Power Switch and Emergency OFF Switches for the Exicor GEN5 System.

To ensure continued safety, all operators should familiarize themselves with the Operators' Safety Summary section, beginning on page 1.

System Initialization

To initialize the Exicor GEN5 system:

1. Turn ON the main power switch on the front of the control system.
2. Turn ON the power to the Scanning Module by pushing in the green button located on the front of the control system.

WARNING

The following step will activate the motion control system. Avoid pinch & crush hazards by staying away from the system when it is in motion.

3. Launch the software program by double clicking on the Exicor desktop icon. Upon system initialization, a diagnostic screen will appear as shown in Figure 3.1. This diagnostic feature verifies proper hardware communication.



Figure 3.1 Hardware Initialization Screen

During hardware initialization, the user will notice the following:

1. The X-Y actuators will move to find their home positions and then move the source and detector modules to a user-defined offset location (if used).
2. The Lock-in Amplifiers will initialize. The front panel of the lock-in amplifier module does not change in any way during initialization.

If there are no errors during the initialization phase, all software indicators will be green and the system is now ready to begin making birefringence measurements.

If an error is witnessed during the initialization phase, identified by a red indicator, see section 7 “Troubleshooting” on page 75 for system initialization errors.

Status Lights

The Exicor GEN5 has 3 status lights mounted to the top of the Source Module as shown in the figure below.

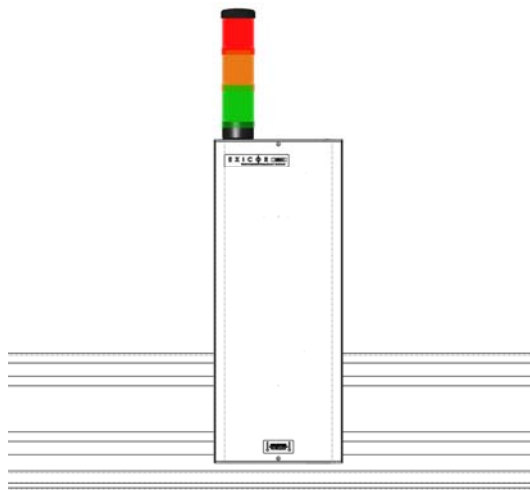


Figure 3.2 Status Light Location

The meaning of each light is as follows:

- **GREEN:** The system has initialized properly and is scanning or is ready to scan
- **AMBER:** The actuators are moving – STAY AWAY FROM THE SYSTEM WHEN THE ACTUATORS ARE IN MOTION
- **RED:** An EMO switch has been pressed. Clear the emergency condition, pull out all EMO switches, power the system ON, and restart the software.

Warm-up Time

The system needs to be powered on for at least 30 minutes prior to making measurements. As the laser inside the source module warms up, its intensity increases then becomes steady after about 30 minutes.

Loading a Sample

Press the **P** button on the software interface to move the gantry to the far back position. This will make sample loading easier and will make sure the sample holder will not hit the source module if the sample tilt feature is being used. Load the sample onto the Max View sample holder so that 2 of its edges are touching both edges of the sample indexing corner as shown on the following page:

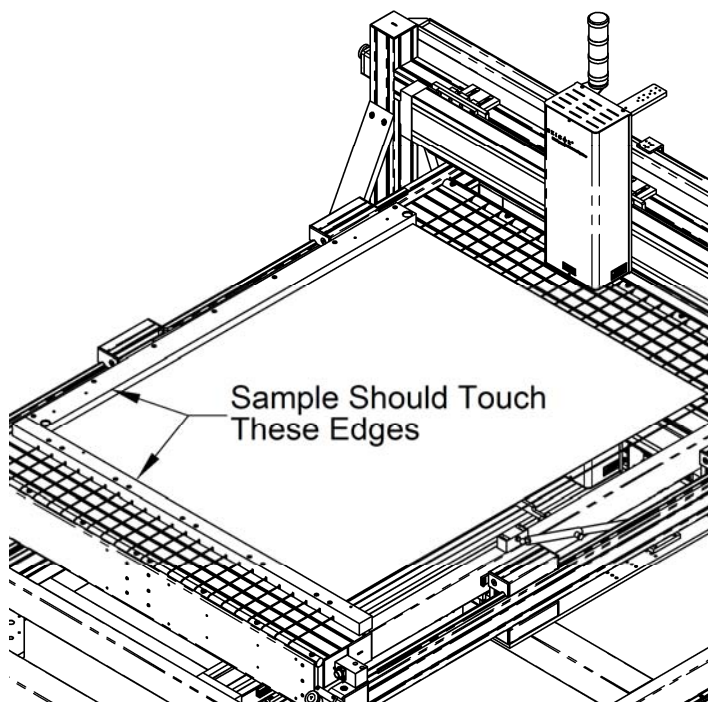


Figure 3.3 Sample Placement on Exicor GEN5

Scanning a Sample

The system can automatically scan various shapes using the automatic scan and macro functions. The following procedure is an example of how to scan a rectangular sample.

1. After the initialization of the system, the main window appears as shown in Figure 3.4.
2. Move the stage so that the light does not pass through the sample but goes straight through to the detector.
3. Click the "Offsets" button in the lower-left portion of the main window. This acquires current data for no sample (air) that will be used to offset the birefringence measurements.

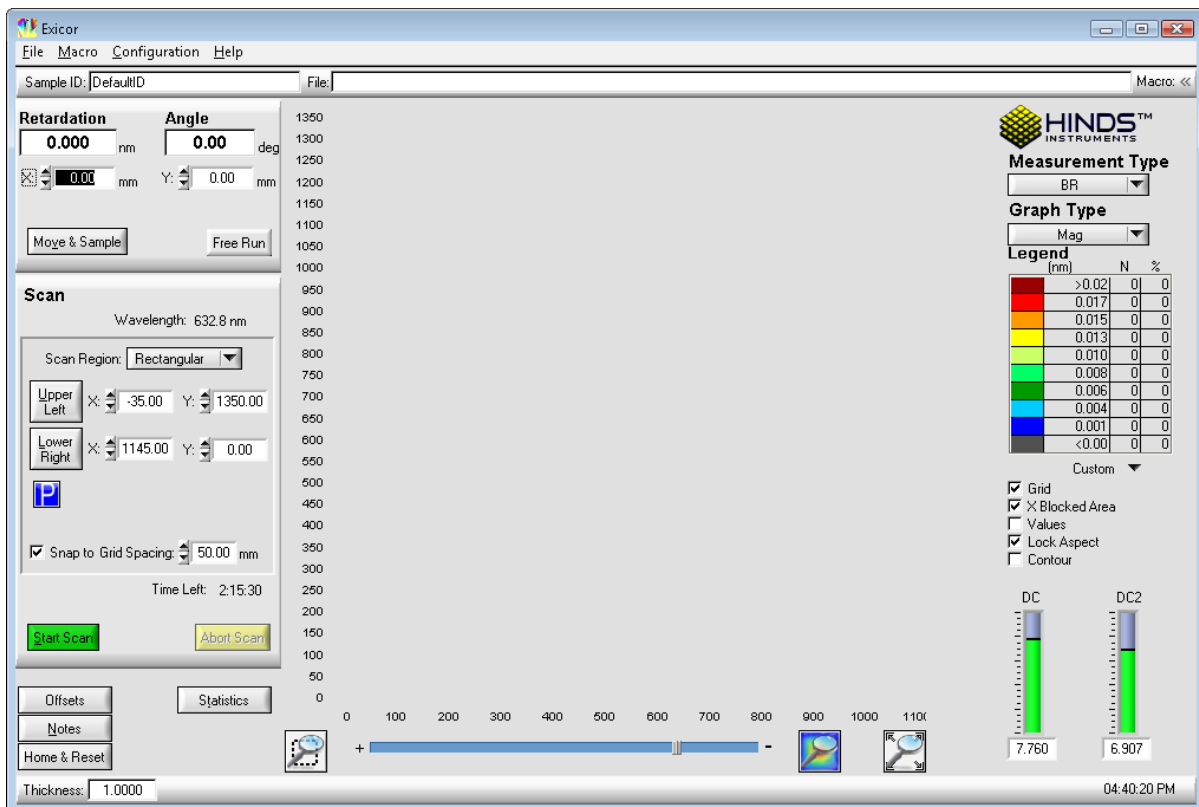


Figure 3.4 Exicor Main Window at Startup

4. Use the arrow keys on the keyboard to move the Source and Detector modules to the (0,0) position. One touch of an arrow key moves the modules by one grid spacing unit. Pressing the control key while using the arrows multiplies the motion step size by 10. Pressing the shift key while using the arrows multiplies the motion step size by 1/10. .
5. Select “rectangular” in the “scan type” drop-down menu.
6. The rectangular scan is defined by an upper left corner and a lower right corner of the sample. Click the mouse on the upper left point of the sample in the “Birefringence Plot” area of the software. Hold the mouse button and drag the pointer down to the lower right corner of the sample. See the following figure for an example of scanning a 1100 x 1300 mm sample.

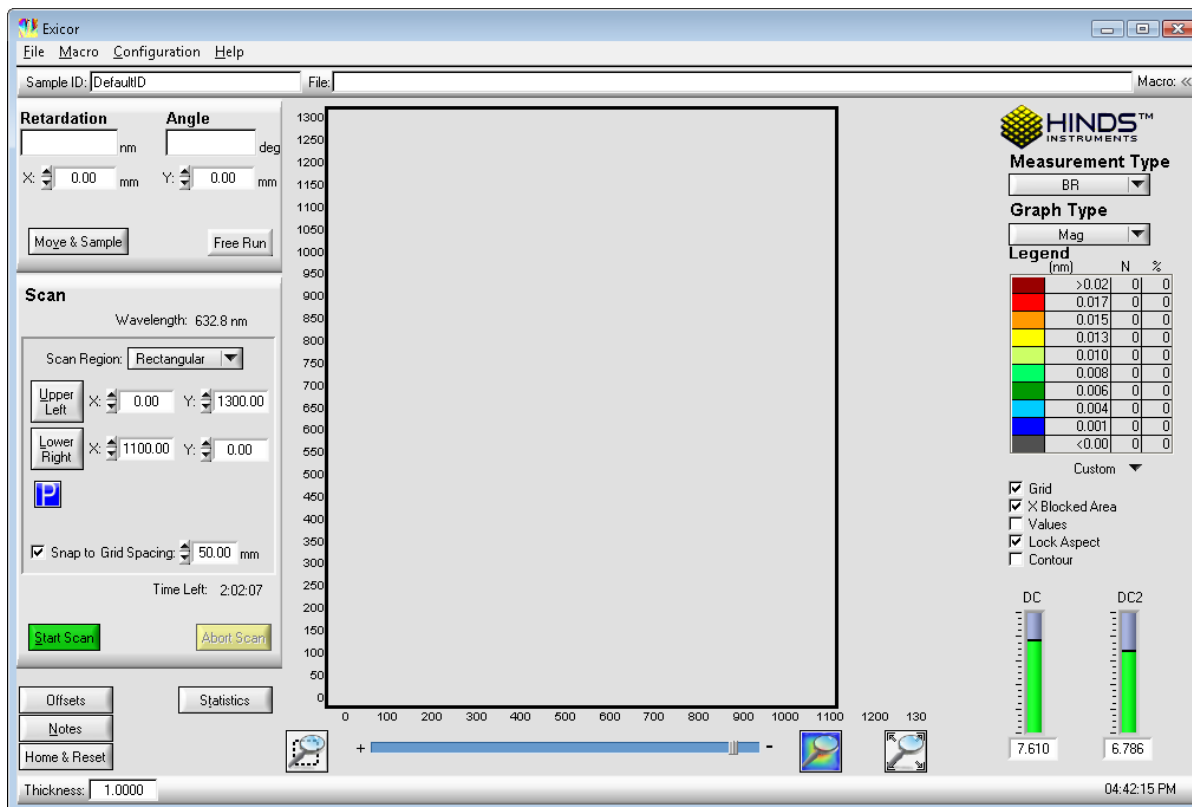


Figure 3.5 Setting up a 1100 X 1300 mm scan

Alternatively, you can enter the coordinates of the lower right corner of the sample in the “scan region” section of the software window.

If the upper left corner of the sample is not at (0,0), enter the coordinates of the upper left corner of the sample as well.

- Click on the **Start Scan** button. The dialog box shown in Figure 3.6 appears, prompting you for a sample ID. Enter a new sample ID or leave the field blank to accept the default sample ID, “DefaultID”.

NOTICE

The software uses the sample ID as the filename. If you do not choose a new name, any existing file with the name DefaultID.DAT is replaced with the new scan.

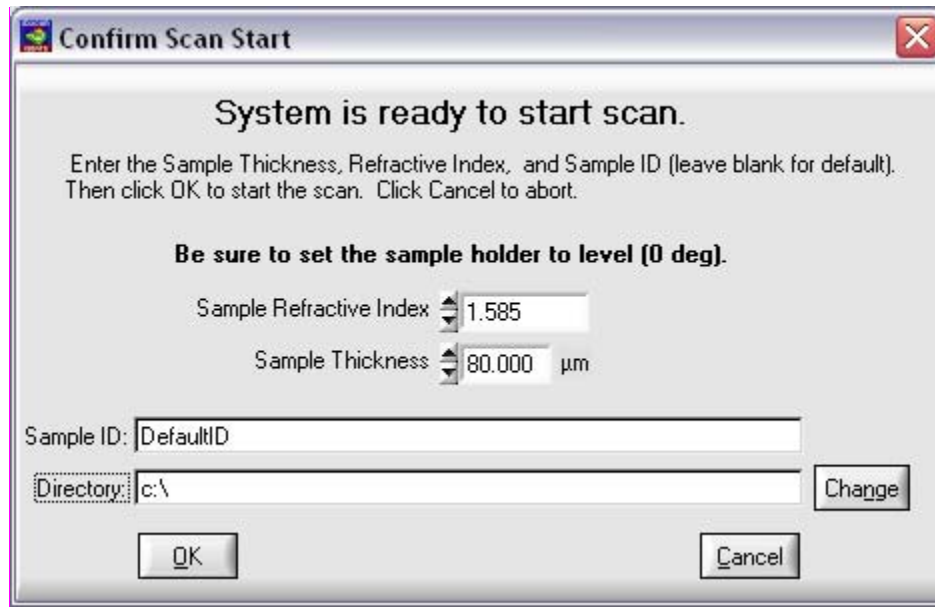


Figure 3.6 Confirm Scan Start Dialog Box

8. Click on the **OK** button in the Confirm Scan Start dialog box to begin the scan.

Scanning and Auto-Calibration Start

Once the scan starts, the data points will begin to appear as each point is measured. A screen similar to the one shown in Figure 3.7 will start to build. These are your results.

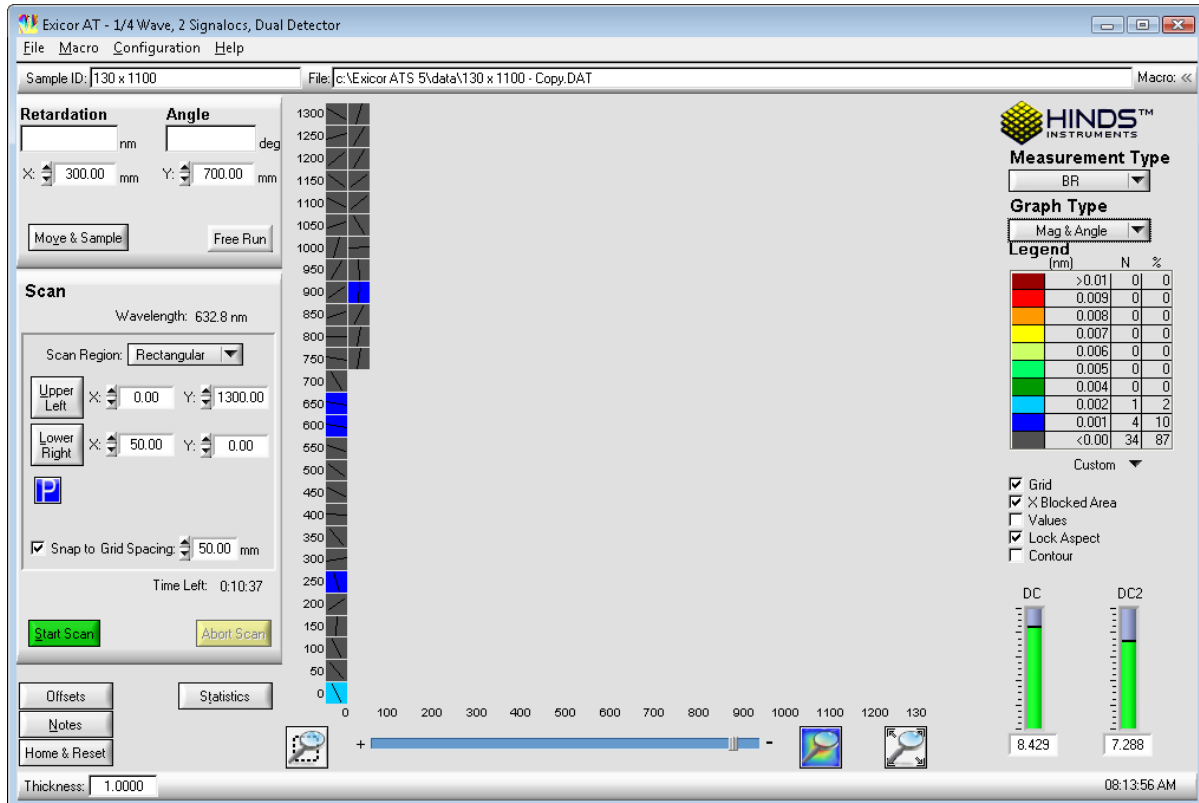


Figure 3.7 Circular Scan In Progress

If you would like to change the Legend colors, double click in the Legend panel and adjust the color range.

While the scan is in progress, you can adjust the color range or select **Magnitude**, **Angle**, **Magnitude & Angle**, or **Stress** from the Graph Type list.

When the scan is complete, X-Y Stage movement ceases and the birefringence plot area of the Exicor main window shows the complete results of your scan, as shown in Figure 3.8.

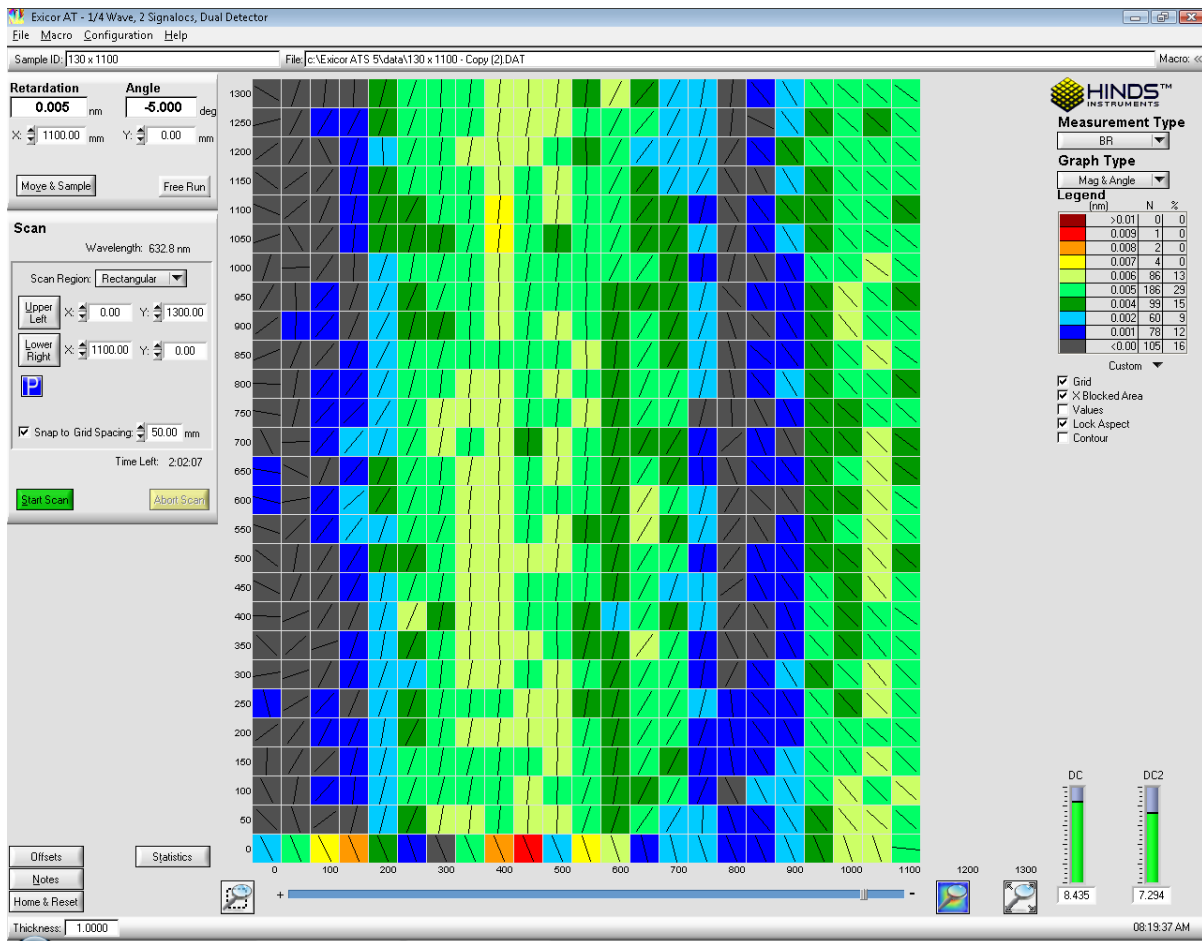


Figure 3.8 Completed Circular Scan

The data has been stored automatically under the Sample ID that was entered before starting the scan. The scan data file is located in C:\Exicor\data\ by default. This can be changed by entering a different location before a scan. The file is of the format "SampleID".dat which is readable by Exicor software and also easy to import into spreadsheet applications. See Appendix C for more information on data formats.

To scan another sample of the same size using the same system configuration, mount the new sample and click on the **Start Scan** button. Enter a sample ID and click on **OK**. The process repeats with your new sample. If the next sample to scan is a different size, you will need to repeat step 6 above to scan the new sample area.

If you enter a new sample ID for the second sample, the software will automatically store to a new data file. **If you use the default sample ID, the new data replaces any data currently stored in the file "DefaultID.dat"**.

The steps you have just performed are sufficient for most applications. See chapter 4 Software Interface for other scan methods.

System Shutdown

1. Ensure that no scan is running. If a scan is in progress and you wish to end it, press the **Abort Scan** button from the software interface.
2. Push the red power button on the front of the Control System. All systems outside the control system will shut down.
3. The PC and monitor can shut down independently as necessary.

4

Software Interface

This chapter describes the Exicor software interface in detail, including the following topics:

- Overview of the Graphical User Interface
- Configuring the System
- Making Birefringence Measurements
- Managing Files

Overview of the Graphical User Interface

All measurement operations (scanning, saving data, generating statistics, etc.) are carried out from the computer screen. Figure 4.1, on the following page, shows the Exicor main window, after a rectangular scan has been completed.

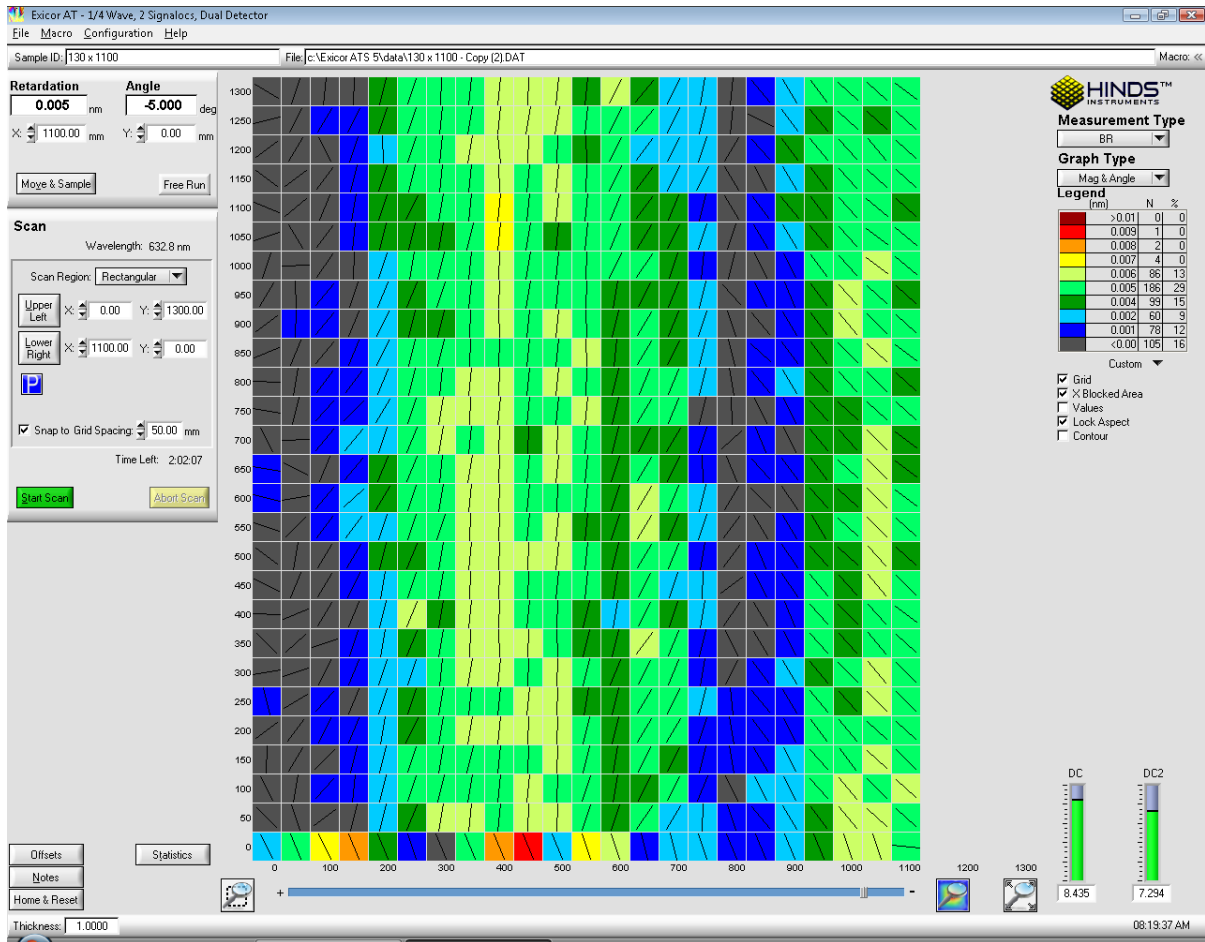


Figure 4.1 Excitor Main Window Showing a Completed Rectangular Scan

The birefringence plot, which is the graphical display of the scan data, appears in the central plot area. The format of your graph depends on the graph type you have selected.

Other buttons and panels in the window allow you to define the scan region, customize the scan, format the graph, etc. Each area and button of this window is further explained in this chapter. The main sections of the Excitor main window are shown in the following figure.

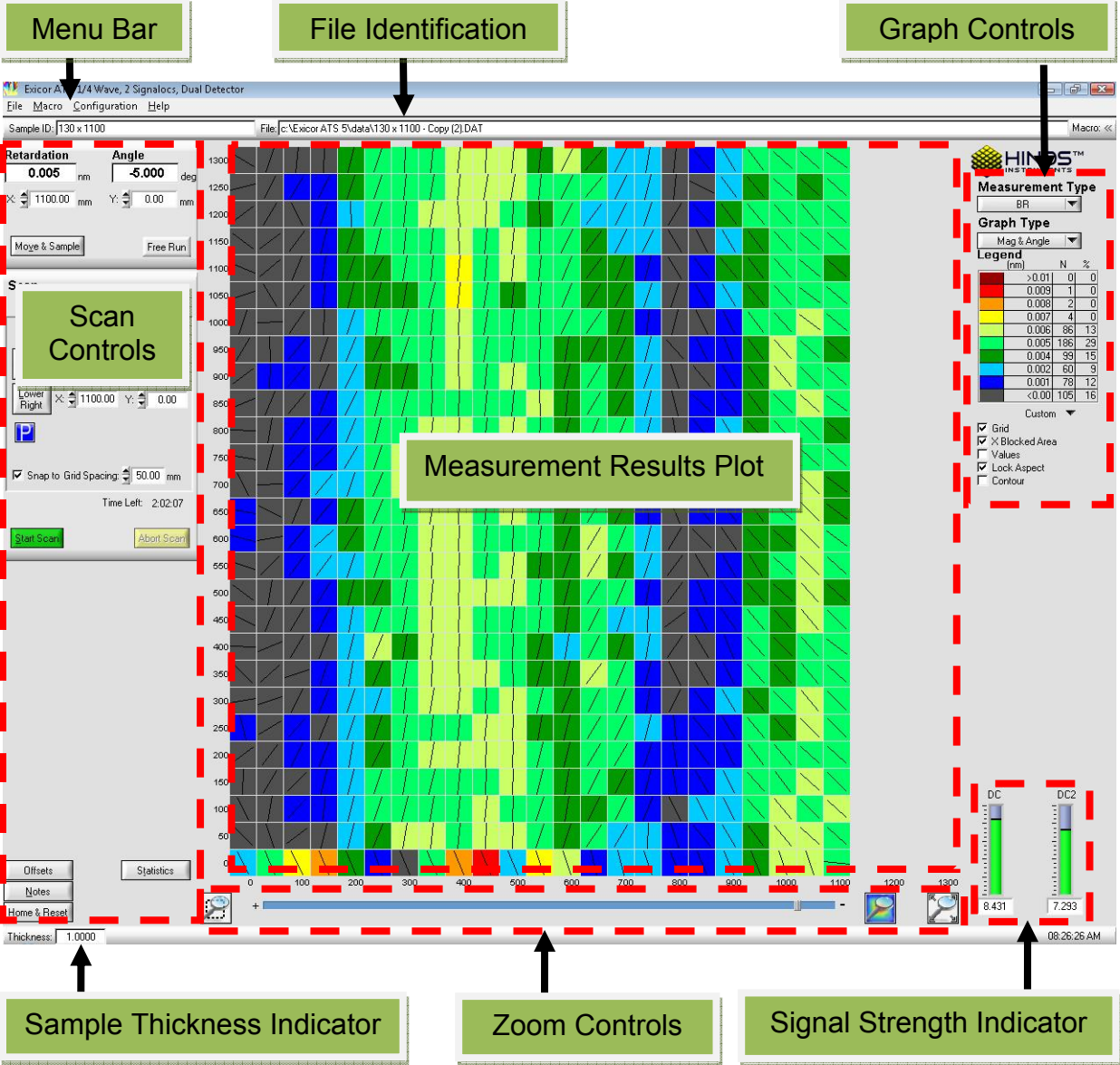


Figure 4.2 Excor Main Window Description

Menu Bar

The menu bar, located at the top of the Excor main window, provides controls for files operations, changing system settings, using macros, and viewing the software version.

Selecting one of these menu options reveals a sub-menu below the item. Select one of the sub-menu items using the mouse or shortcut key.

The menu bar offers the following choices:

File: controls related to new file creation, opening, saving, printing, copying data files, and exit. Recently opened files are shown and can be reopened by clicking on them.

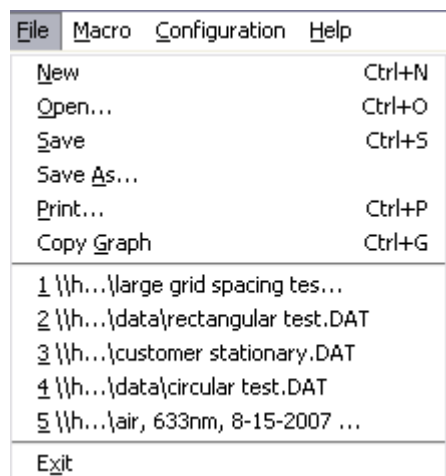


Figure 4.3 File Menu

Macro: controls related to loading, unloading, creating and editing macros.

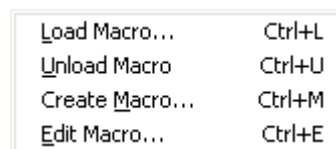


Figure 4.4 Macro Menu

Configuration: controls related to configuring system parameters and auto-calibration settings.

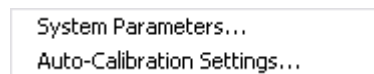


Figure 4.5 Configuration Menu

Help: information on the currently installed version of the Exicor software.

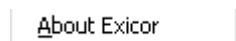


Figure 4.6 Help Menu

File Identification

Figure 4.7 shows the file identification information, located at the top of the Exicor main window.



Figure 4.7 File Identification Information

The **Sample ID** field displays the sample ID associated with the open file. See “Saving a File” on page 58 for more information on sample IDs.

The **File** field displays the file name of the current data file. If you have not yet scanned or loaded a file, the **File** field is empty.

The **Macro** field displays the macro currently loaded in memory. See Chapter 5 beginning on page 63 for information on using macros with the Exicor GEN5 system.

Interactive Scan

Figure 4.8 shows the Interactive Scan panel, located at the upper left-hand side of the Exicor GEN5 main window.

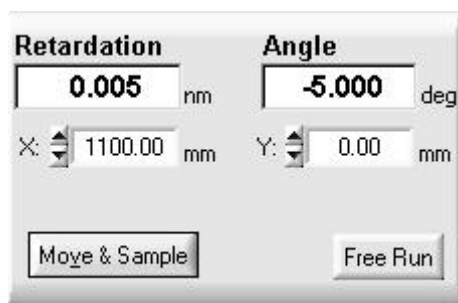


Figure 4.8 Interactive Scan Panel

The Interactive Scan panel is used for single-point measurements only. See Making Birefringence Measurements on page 42.

Automatic Scan

Figure 4.9 shows the Automatic Scan panel, located at the left-hand side of the Exicor main window under the Interactive Scan Panel.

This panel is used to select scan region (Rectangular, Circular, Center-radius, or Stationary). See Making Birefringence Measurements on page 42.

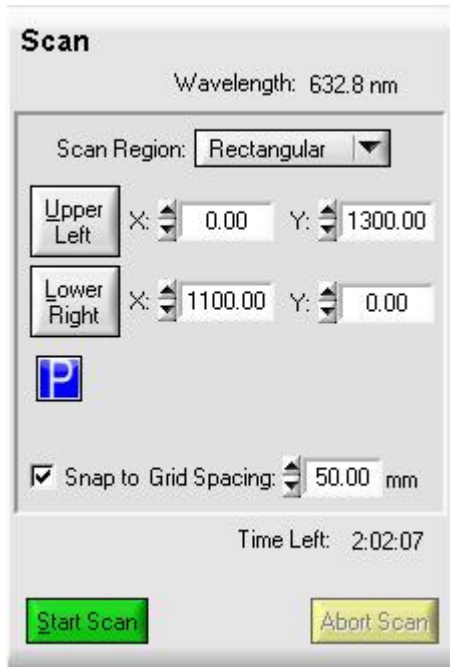






Figure 4.9 Automatic Scan Panel

Birefringence Plot Area

The birefringence plot area shows the currently active measurement data or currently open data file.

Using a mouse, you can select a grid point to display the measured data in the Interactive Scan panel. If you select more than one grid point (by dragging the mouse), you can either outline an area for a new scan or you can zoom in on the

area with the  button. The coordinates of the selected area are displayed in the Automatic Scan panel.

The  button allows you to zoom in on a grid point or points. The  button allows you to zoom in on the data from a completed scan. Click the  button to show the entire scannable area. Alternatively the mouse wheel can be used for zooming in and out.

By double-clicking on a grid point, you command the system to move to that location and take a measurement (the same as clicking once and then clicking the Move & Sample button). A cross-hair which represents the current stage position is displayed.

The default grid spacing is set at 50mm. If necessary, you can change the grid spacing and grid units. See “Changing the Grid Spacing” and “Changing the Stage Distance Units” on page 39 for more information.

Other Displays and Controls

Figure 4.10 shows the real-time signal DC portion of the detector signal. The DC level is important because it represents the light intensity that is reaching the detector. A low DC level means the light is being blocked in some way. More light reaching the detector means more signal strength and less noise in the measurement. See the Troubleshooting chapter for more information.

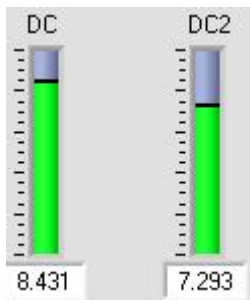


Figure 4.10 DC Level Indicator

Figure 4.11 shows the **Offsets**, **Notes**, and **Home & Reset** buttons in the lower-left area of the Exicor window..

Clicking on the **Offsets** button performs a single point measurement at the current x-y position to use as a baseline for sample measurements. There should be no sample in the beam path when pushing the **Offsets** button. Clicking on the **Home & Reset** button reinitializes the system hardware. The **Notes** button is used to add comments to the current data file. The **Statistics** button shows the birefringence magnitude and fast axis angle statistics for the current scan.



Figure 4.11 Offsets, Home & Reset, Notes

Figure 4.12 shows the status bar located at the bottom of the Exicor GEN5 main window.

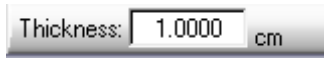


Figure 4.12 Sample Thickness Indicator

This bar shows the sample thickness that has been entered by the user. It is important to have an accurate sample thickness if you wish to plot the differential stress in the sample. The sample thickness is for display only and can be changed by starting a new scan and defining new sample thickness as described on page 24. It can also be changed in the system settings window.

Configuring the System

You can adjust many aspects of the scanning process by changing various values and settings. Use Table 4.1 as a quick reference when changing system parameters.

This Parameter	Is Changed Here
Birefringence Units	Configuration --> System Parameters
Offsets	Main Window or Configuration --> System Parameters
Number of Averages	Configuration → System Parameters
Sensitivity	Configuration → System Parameters
Sample Thickness	Configuration → System Parameters
Stage Distance Units	Configuration → System Parameters
Grid Spacing	Main Window or Configuration --> System Parameters
Stage Home Position Offset	Configuration → System Parameters
Enable Auto Calibration	Configuration → Auto-Calibration Settings
Auto-Calibration Location	Configuration → Auto-Calibration Settings
Num Offset Samples	Configuration → System Parameters OR Configuration → Auto-Calibration Settings

Table 4.1 Summary of Where to Change System Parameters

System Parameters Control Window

To access the System Parameters dialog box (shown in **Error! Reference source not found.**), select **Configuration --> System Parameters** from the Exicor menu bar.

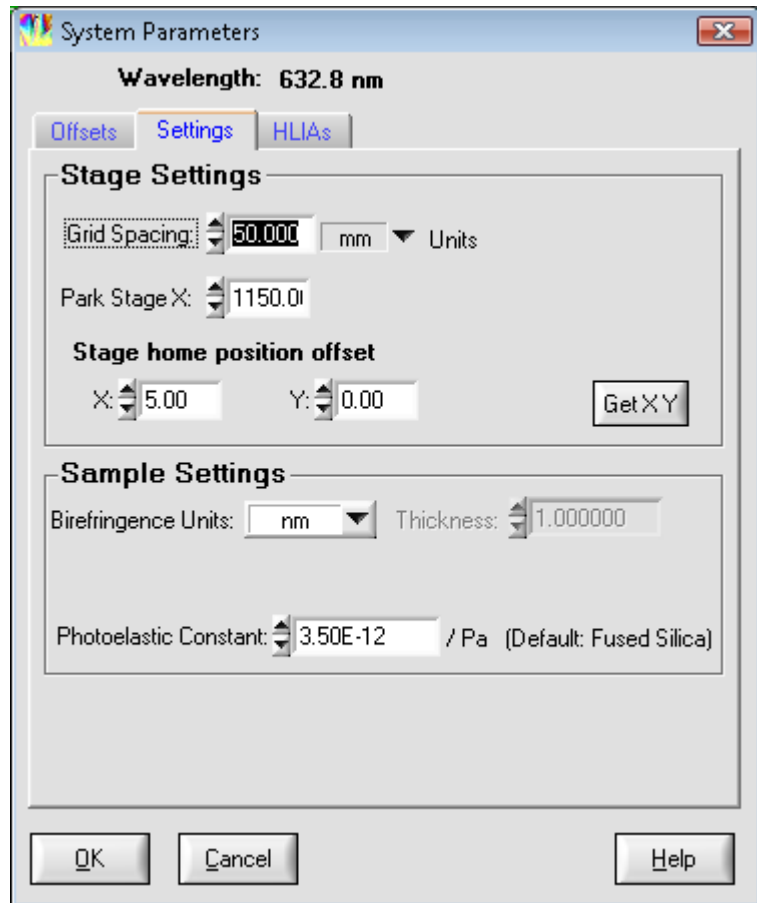


Figure 4.13 System Parameters Dialog Box

Changing the Number of Measurement Averages

A larger number of measurement averages will result in less noise in the measurement. However a smaller number of measurement averages will decrease the amount of time required for the scan.

To change the number of measurement averages taken for offset measurements, go to the **HLIAs** tab. Click on the ▲ or ▼ arrows to change the number of samples.

Changing the Sensitivity

This control sets the voltage range that is used by the lock-in amplifier for acquiring the detector signals. This has been set from the factory to the optimum setting for low birefringence LCD glass samples and should not need to be changed.

In general, low birefringence samples result in small signals on the lock-in amplifiers and high birefringence samples result in larger signals. Using a lower sensitivity range allows the lock-in to acquire smaller signals with finer resolution. Using a higher sensitivity range allows the lock-in to measure larger birefringence.

If the sample birefringence creates a signal that is out of the range of the lock-in sensitivity, a dialog box will pop up indicating an error. 0.1562 V is a good general setting for low birefringence samples. 1.25 V should cover the entire measurement range of the instrument but will not be quite as sensitive for low birefringence measurements.

To change the sensitivity setting, go to the **HLIAs** tab. Click on the ▲ or ▼ arrows to change the setting.

Changing the Stage Distance Units

To change the distance units used in the birefringence plot area of the Exicor main window, go to the **Settings** tab then go to the **Stage Settings** section and adjust the parameter in the **Stage Distance Units** field.

The available stage distance units are:

- millimeters (mm)
- centimeters (cm)
- inches (in).

The default is mm.

When you change the stage distance units, the birefringence plot is redrawn and references to positions in the Interactive and Automatic Scan panels are updated. The new units are reflected in the **Grid Spacing** field in the Exicor main window.

Changing the Grid Spacing

The default grid spacing (step size of the X-Y-Motion Stage) in the birefringence plot area is 50mm. The **Grid Spacing** field is located on the main window and in the System Parameters window. Click on the ▲ or ▼ arrows to change the grid spacing or enter a number in the field and push the Tab key.

The new grid spacing value does not take effect until you select **File --> New** or click on the **Start Scan** button and start the scan.

Stage Home Position Offset

The stage home position refers to the location where the stage moves to upon starting the Exicor software. This position is used as the 0,0 position for sample measurements. The stage offset fields are located under the **Stage Settings** section of the **Settings** tab. Click on the **Get X Y** button to set the home position to

the current stage (X,Y) position. It is also possible to change the stage home position by clicking on the ▲ up or ▼ down arrows for the X and Y coordinates.

Auto-Calibration Settings Control Window

The Auto-Calibration feature is used to perform measurement offsets automatically before and during a sample scan. To access the Auto-Calibration settings, select **Configuration-->Auto-Calibration Settings** from the Exicor menu bar.

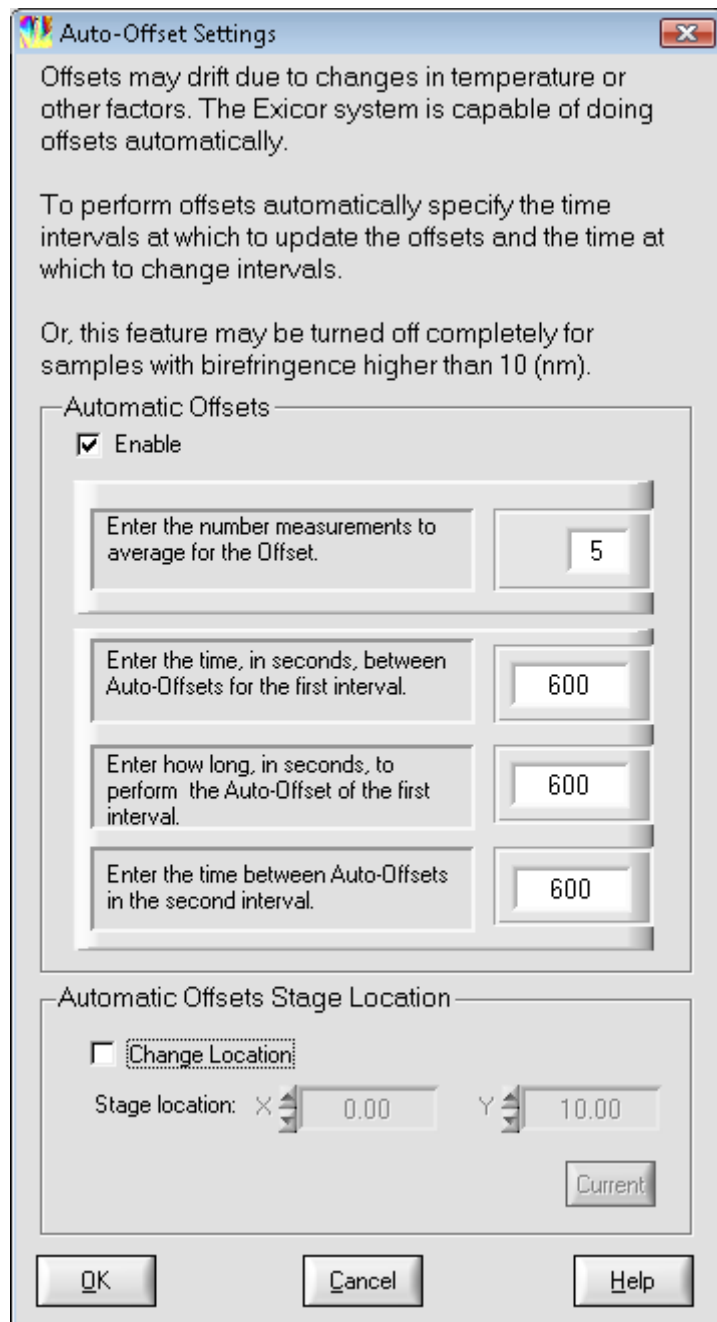


Figure 4.14 Auto Calibration Settings Dialog Box

Changing Frequency of Auto-Offsets

In order to access the auto calibration feature, check the **Enable Auto-Calibration** box. Auto-offset settings are defined in 4 ways:

1. The number of offset measurements to take and average together (the default is 5)
2. The time between each auto-offset measurement sequence in the first time interval. The units are seconds (the default is 600).
3. The length of the first time interval in seconds (the default is 600).
4. The time between each auto-offset measurement sequence after the first time interval. The units are seconds (the default is 600).

With the default settings, the system will make 5 offset measurements and average them together for the air offset. It will do this every 10 minutes (600 seconds) for the first 10 minutes of the scan. After the first 10 minutes of the scan, the system will continue to do an auto-offset every 10 minutes.

Changing Location of Auto-Offsets

To change the location for auto-offset, check the **Change Auto-Calibration Location** box.

Note: The auto-calibration location must be a position in the X-Y-Motion Stage where no sample is present and the beam is unobstructed (not passing through a sample). Once set, click **OK** to save settings.

Making Birefringence Measurements

The Exicor main window lets you perform two types of measurements:

Single Point Measurements

are useful in the following situations:

- you are defining the boundary of a sample area
- you want to display the measured values of a grid point on the birefringence plot
- you want to make an individual reading at a particular location.

Area Measurements

are useful when you want to gather large amounts of data with minimal user attention. Area measurement types available are rectangular and circular. Measurements are stored in a user-specified file.

Performing a Point Measurement

Figure 4.16 shows the Interactive Scan panel, located on the left-hand side of the Exicor main window:

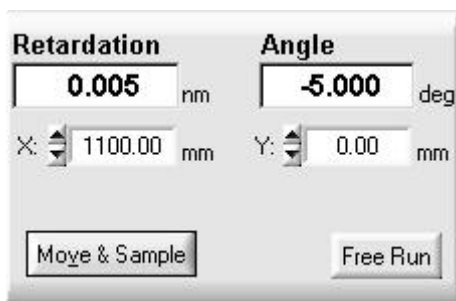


Figure 4.15 Interactive Scan Panel

The Interactive Scan panel is used for single-point measurements only. If you want to scan an entire region, use the Automatic Scan panel, as described on page 45.

To take a Single-Point measurement, use one of the following techniques:

- Double-click on the grid point at which you want to take a measurement. This moves the stage to the selected position and takes a measurement.
- Enter the X and Y coordinates of the grid point at which you want to take a measurement into the X and Y fields in the Interactive Scan panel, and then click on the **Move & Sample** button.
- Use the cursor keys on the keyboard to move the stage position (the X and Y fields are updated), and then click on the **Move & Sample** button.

Using any of these techniques, the results of the measurement are displayed in the **Retardation** and **Angle** fields in the Interactive Scan panel.

The fast axis angle measurement ranges from -90° to $+90^{\circ}$. Use the following figure as a reference for fast axis angle measurements.

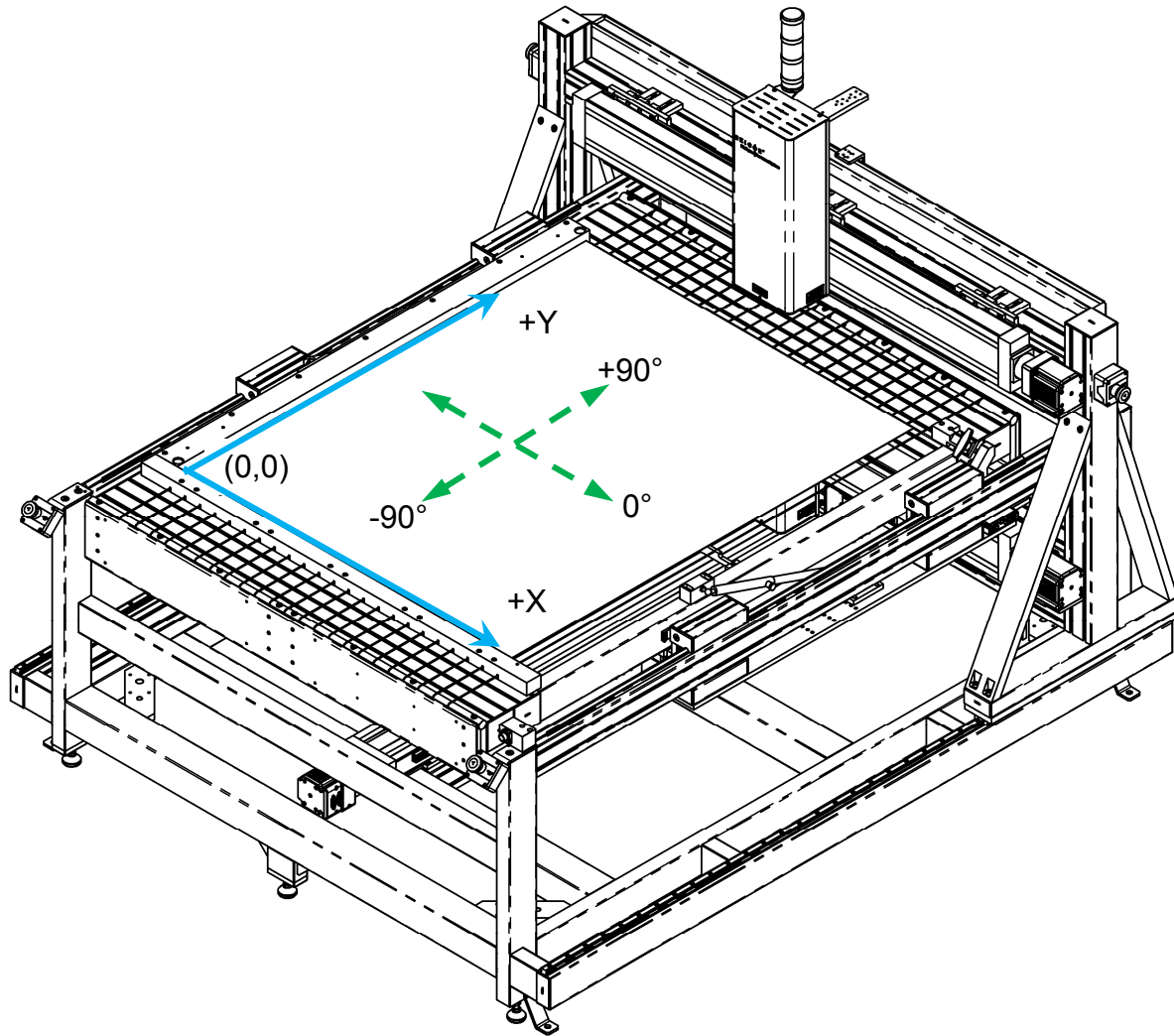


Figure 4.16 X-Y Motion & Fast Axis Angle

If the Retardation field reads “BLOCKED”, this means there is not enough light getting to the detector. See Chapter 7 on page 75 for more information on dealing with “BLOCKED” measurement results.

Using Cursor Keys to Move the Stage Position

Table 4.2 shows how to use the arrow cursor keys to move the current stage position. The current stage position is displayed in the **X** and **Y** fields in the Interactive Scan panel.

Pushing this Key	Has this Effect
arrow keys	moves the stage 1 grid space.
Holding "CTRL" while pushing arrow keys	moves the stage 10 grid spaces.
Holding "SHIFT" while pushing arrow keys	moves the stage 1/10 of a grid space.

Table 4.2 Using Cursor Keys to Move the stage Position

Moving the stage position with the cursor keys does not take a measurement; to take a measurement, click on the **Move & Sample** button in the Interactive Scan panel.

The current stage position is denoted by the cross-hair in the birefringence plot area and by the X & Y boxes of the Interactive Scan Panel.

Performing an Area Measurement

Before you begin your scan, you must define a scan region and scan settings, as discussed in the following section.

Defining a Scan Region

The available scan regions are:

- **Circular:** circular scan defined by 3 points on the circumference
- **Center/Radius:** circular scan defined by a center and radius
- **Rectangular:** rectangular scan area defined by the upper left corner and the lower right corner
- **Stationary:** repeated measurement of a user-defined point in the scan area

Set the shape of the scan region by clicking on the down-arrow next to the **Scan Region** field in the Automatic Scan panel.

Defining a Rectangular Scan Region

When defining a Rectangular Scan Region, first click on the down-arrow next to **Scan Region** in the Automatic Scan panel and select **Rectangular**.

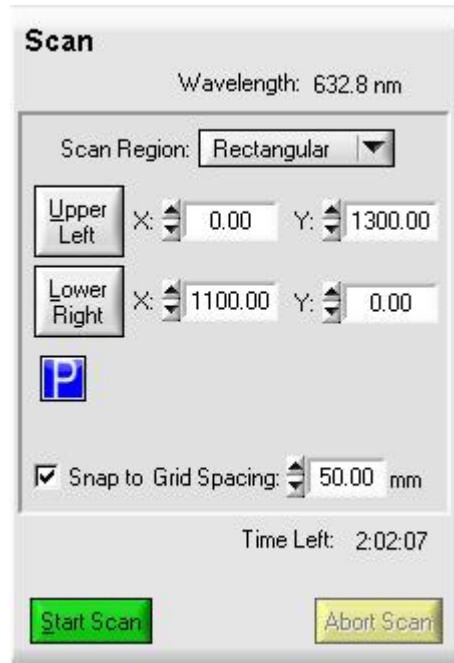


Figure 4.17 Automatic Scan Panel for Rectangular Scans

This method requires the user to find and enter the location of the **Upper Left** corner of the rectangular sample and the location of the **Lower Right** corner of the sample.

Click on the **Upper Left** or **Lower Right** button in the Automatic Scan panel to set that scan coordinate to the current stage position.

Defining a Circular Scan Region

When defining a Circular Scan Region, first, click on the down-arrow next to **Scan Region** in the Automatic Scan panel and select **Circular**.

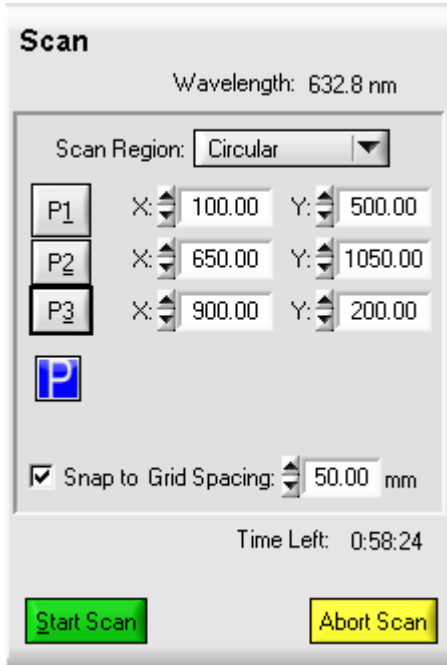


Figure 4.18 Automatic Scan Panel for Circular Scans

A circular scan is defined by 3 points on the circumference of the circle. It is best to define the points to be far away from each other (as in the following figure).

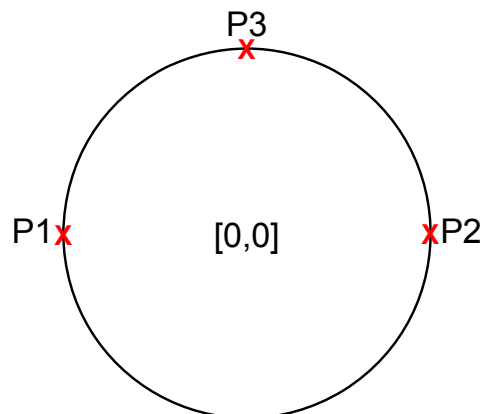


Figure 4.19 Points to Define a Circular Scan

To define a circular scan:

1. Use the arrow keys to move the laser beam to the edge of the sample. Click "P1".
2. Use the arrow keys to move the laser beam to another point on the edge of the sample. Click "P2".
3. Use the arrow keys to move the laser beam to another point on the edge of the sample. Click "P3".

Once the 3 points are defined, the Exicor software will trace out a circle showing the scan area. The following figure shows an example of a circular scan that has been defined.

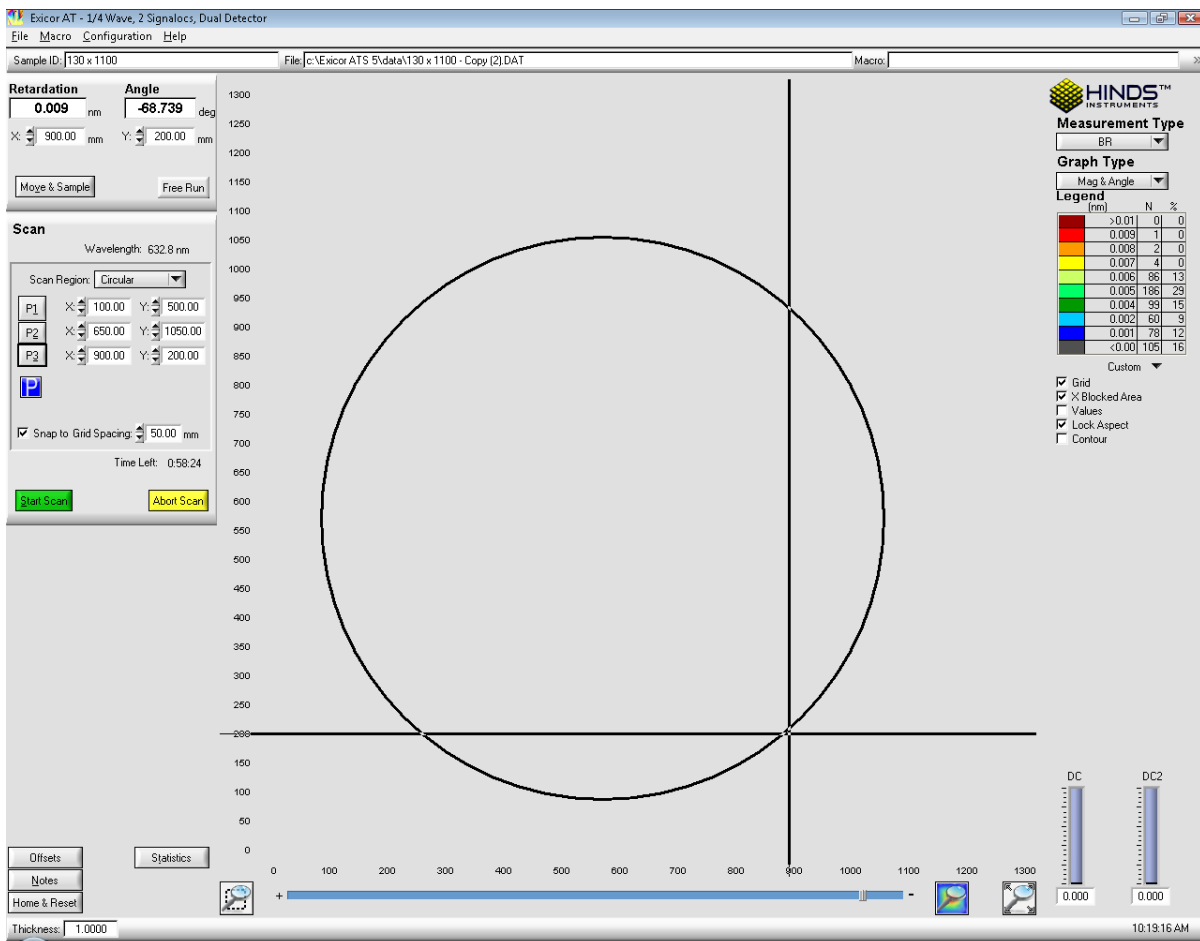


Figure 4.20 Defining a Circular Scan

Defining a Center/Radius Scan Region

When defining a Center/Radius Scan Region, first, click on the down-arrow next to **Scan Region** in the Automatic Scan panel and select **Center/Radius**.

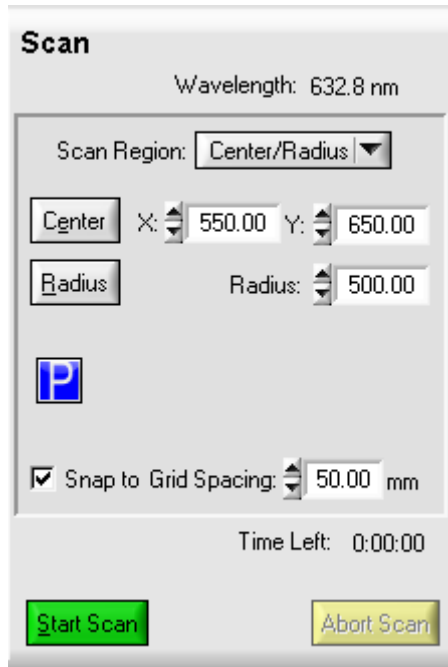


Figure 4.21 Automatic Scan Panel for Center/Radius Scans

Define this scan using any one of these methods:

- Click and drag to define a circle. The point where you first click will be the center of the circle. Hold the mouse button down and drag the mouse to define the radius.

OR

- Enter the X and Y coordinates of the center of the circular sample then enter the radius of the sample.

OR

- Move the laser beam to the center of the sample and click the **Center** button. Move the laser beam to the edge of the sample and click the **Radius** button.

When you have completely defined the scan, the Excior window will look like the following figure:

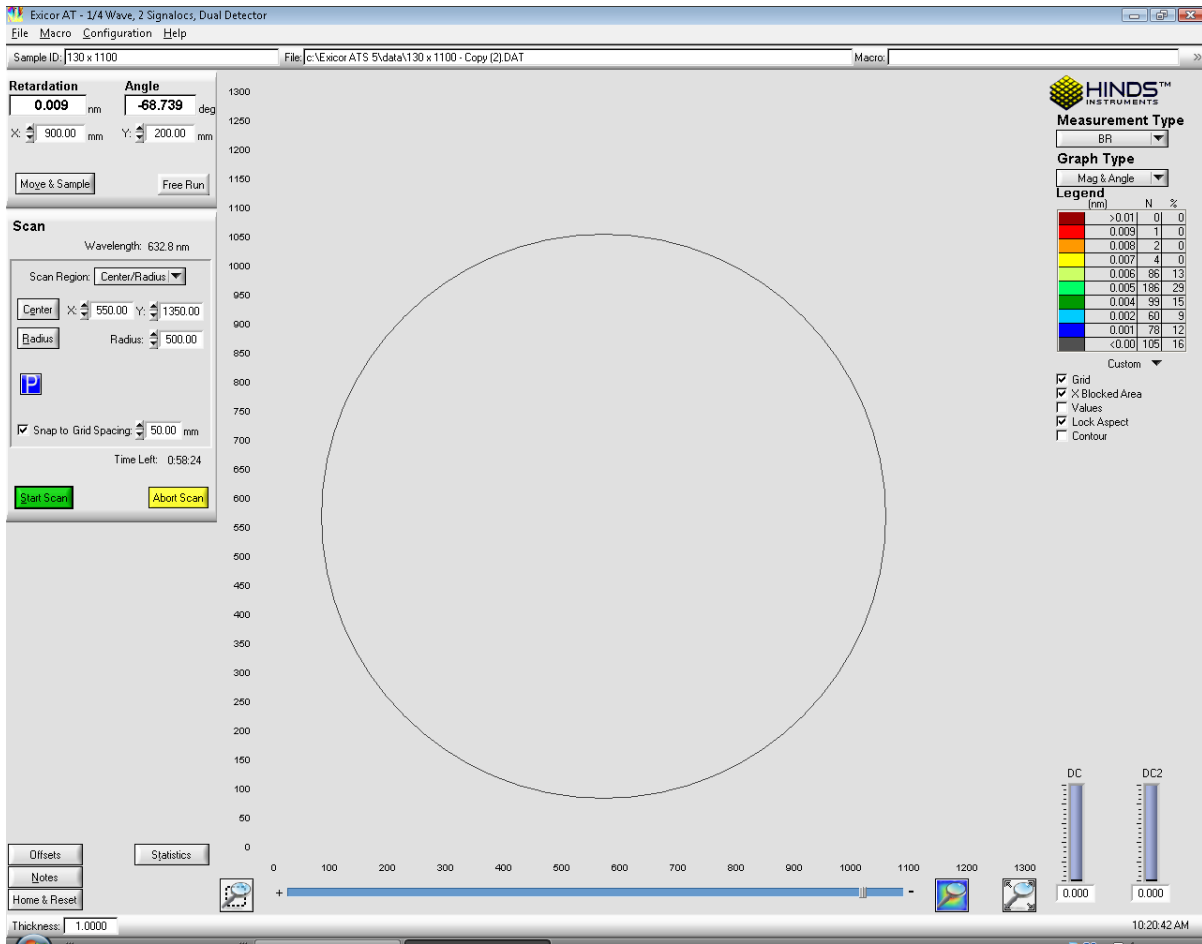


Figure 4.22 Defining a Center/Radius Scan

Defining a Stationary

The stationary scan type is used to repeatedly measure the same X-Y point on a sample. To define a Stationary Scan, first, click on the down-arrow next to **Scan Region** in the Automatic Scan panel and select **Stationary**.

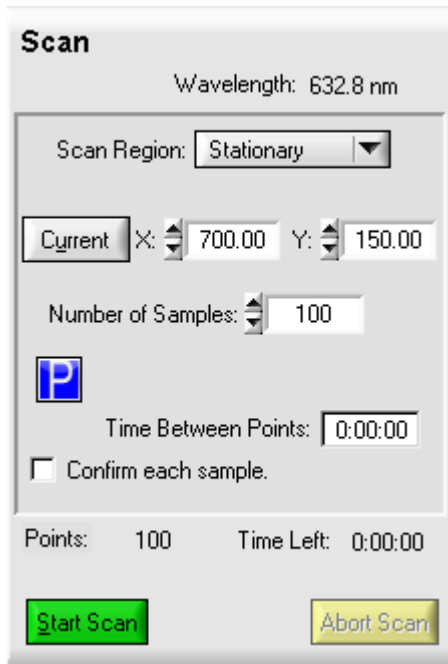


Figure 4.23 Automatic Scan Panel for Stationary Scans

Define this scan using any one of these methods:

- Enter the X and Y coordinates of the point to measure and enter the number of times to measure the point.

OR

- Move the laser beam to the desired sample location and click the **Current** button. Then enter the number of times to measure the point.

Performing the Scan

After the scan type has been selected and the area has been defined, follow these steps to perform an automatic scan:

1. Click on the Start Scan button.
2. After the hardware is ready to scan, the Confirm Scan Start dialog box appears as shown in Figure 4.24. Enter the sample ID, or leave it blank for "DefaultID", as described later in this chapter.

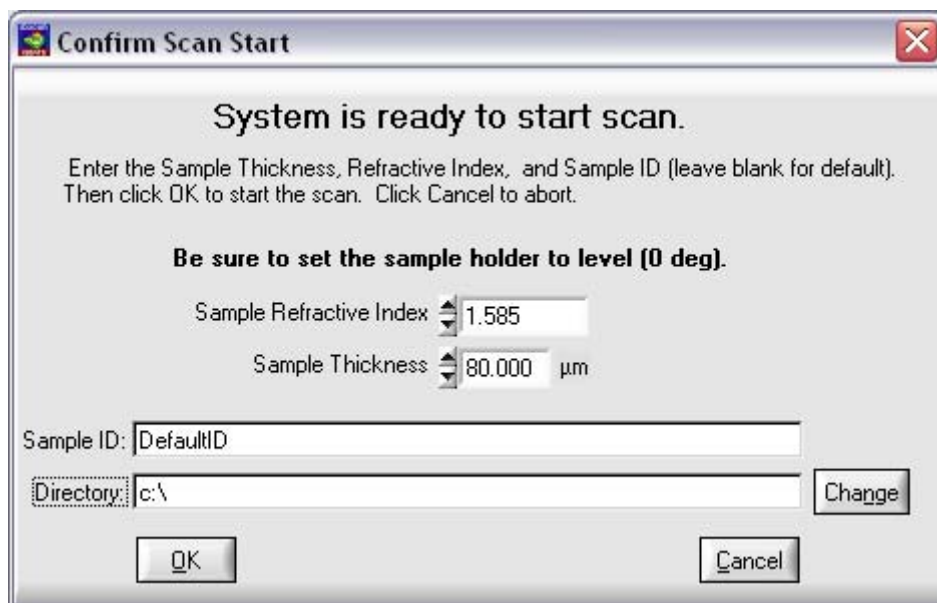


Figure 4.24 Confirm Scan Start Dialogue Box

3. Enter the sample thickness if necessary. This only applies if the birefringence units are set to nm/cm or nm/inch.
4. Click on **OK** to close the Confirm Scan Start dialog box.

The automatic scanning process begins as soon as **OK** is pushed. The data will be taken in a serpentine fashion starting at the top of the sample. During scanning, you will notice periodic excursions of the X-Y-Motion Stage as the auto-calibration feature operates. The **Est. Time Remaining** field, within the scan panel, shows approximately how much time is left until the end of the current scan.

After the scan is complete, the data is saved automatically.

You can change the legend colors and values and enter annotations about the sample, as described in “Customizing Your Scan” later in this chapter.

If you have added annotations, need to change the sample ID, or have changed the legend colors or range settings for the file, you should save the data by clicking **File** ---> **Save**. Enter the new sample ID when prompted if you want to change the sample ID. Then select the path and name of the file to which to save the data.

Viewing the Scan Results

The Exicor software offers several controls to modify the display of your scan data:

- Graph Type
- Legend
- Scan Statistics

Graph Type

The figure below shows the Measurement Type and Graph Type control panel which is located at the upper right-hand side of the Exicor main window.

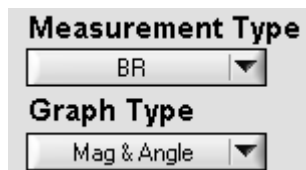


Figure 4.25 Measurement/Graph Type

The **Measurement Type** control changes which type of data is shown. The options are

- **BR:** Linear Birefringence (units can be nm, nm/cm)
- **STRESS:** Differential stress (units are psi). This is not an absolute stress measurement. The system can determine the magnitude of the stress but cannot determine for certain if the stress is compressive or tensile.

The **Graph Type** control selects the method to display either the birefringence or stress data. The options are

- **Mag:** shows only the retardation magnitude or stress color plot.
- **Angle:** shows only the fast axis angle vector plot. The fast axis angle cannot be shown while stress is the selected measurement type.
- **Mag & Angle:** shows both the magnitude color plot with the angle vector plot overlaid on top. The fast axis angle cannot be shown while stress is the selected measurement type.
- **Mag 3D:** shows a 3-dimensional surface representation of the retardation or stress magnitude.

Legend

Figure 4.23 shows the Legend, located at the upper right-hand side of the Exicor GEN5 main window.

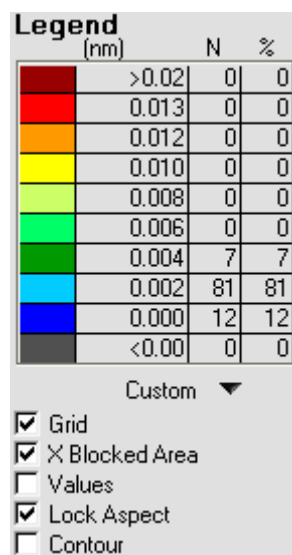


Figure 4.26 Birefringence Plot Legend

The legend describes the color key for the retardation or stress magnitude plot. The legend also lists the number of data points containing each color in terms of absolute number and percent of the total.

X Blocked Area: checking this box displays measurement points with low light intensity as “X”. If the box is not checked, low light intensity points are not shown (same color as background).

Grid: checking this box shows the scan area grid lines. If the box is not checked, scan grid lines will not be shown.

You can change the colors associated with various ranges of birefringence magnitude data by double-clicking on the legend then editing the legend settings. See Figure 4.24 for the legend settings window.

Values: checking this box displays the retardation or stress magnitude value on each data point in the 2D plot. This feature is disabled when the boxes representing each point are very small.

Lock Aspect: checking this box keeps the shape of the data points square on the 2D plot. If this box is unchecked, the data points may become stretched in certain zoom conditions.

Contour: checking this box displays contour lines overlaid on the color and vector plots. The contour lines enclose areas of different retardation magnitude.

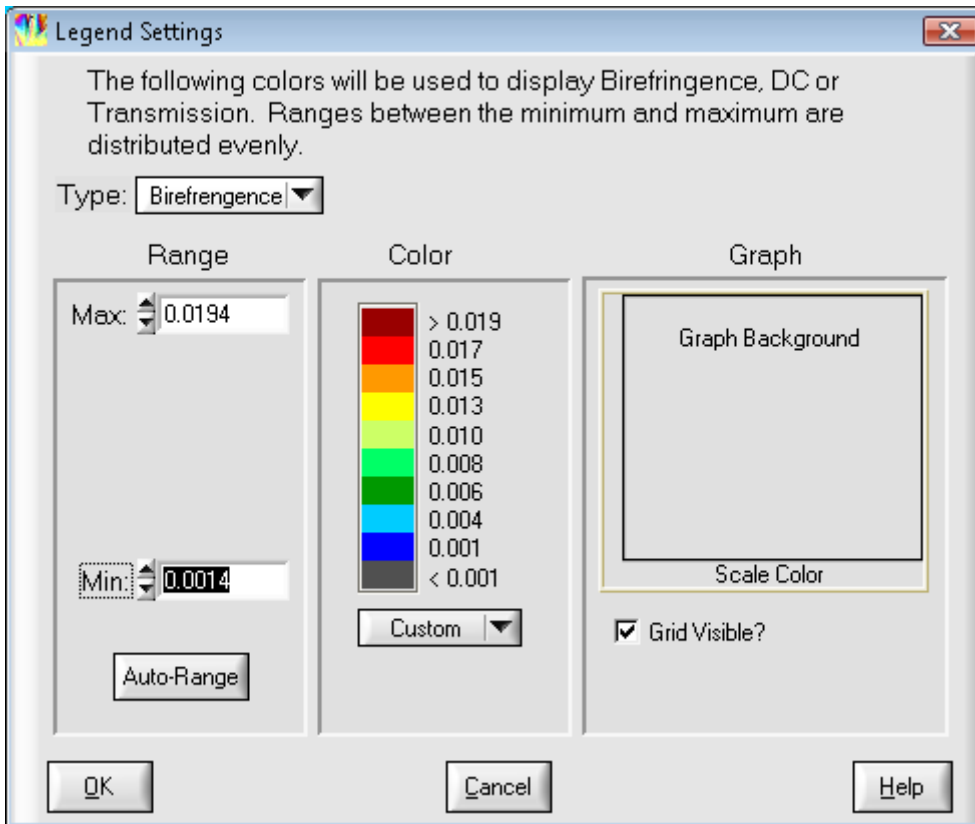


Figure 4.27 Legend Settings Window

Type: Select the measurement type to apply the color to. The user selection is saved each time the file is saved so that the legend preferences for each measurement type are preserved for future viewing at the same settings.

Range: Enter the desired maximum and minimum numbers desired for the retardation legend. Pushing the **Auto-Range** button selects a range according to the maximum and minimum retardation of the scan.

Color: The “Custom” setting divides the retardation range into 10 sub-ranges and assigns a distinct RGB color to each sub-range. The “Gray Scale” setting sets each sub-range to a different shade of gray. The “Spectral” setting sets each sub-range to a distinct color from purple at the low end to red at the high end. The “Gray Scale” and “Spectral” color types display the color on a continuous gradient instead of in sub-ranges.

Graph: Clicking on the “Graph Background” area or the “Scale Color” area allows the user to change the color of these areas of the Birefringence Plot area.

Scan Statistics

Clicking on the **Statistics** button in the Exicor main window opens the Statistics dialog box, shown Figure 4.28.

Statistics for all data points.

N = (Number of points with Mag > 0)

	Min	Max	Mean	Std Dev	3 Std Dev
Magnitude	<input type="text" value="0.000"/>	<input type="text" value="0.009"/>	<input type="text" value="0.0037"/>	<input type="text" value="0.0018"/>	<input type="text" value="0.0055"/>
Angle	<input type="text" value="-89.65"/>	<input type="text" value="89.96"/>	<input type="text" value="26.699"/>	<input type="text" value="62.2167"/>	<input type="text" value="186.6501"/>
Stress (psi)	<input type="text" value="0.000"/>	<input type="text" value="7.724"/>	<input type="text" value="0.2199"/>	<input type="text" value="0.49813"/>	<input type="text" value="1.49440"/>

Statistics for data points of selected area.

N = (Number of selected points with Mag > 0)

	Min	Max	Mean	Std Dev	3 Std Dev
Magnitude	<input type="text" value="0.000"/>	<input type="text" value="0.001"/>	<input type="text" value="0.0008"/>	<input type="text" value="0.0004"/>	<input type="text" value="0.0013"/>
Angle	<input type="text" value="-57.10"/>	<input type="text" value="68.53"/>	<input type="text" value="17.069"/>	<input type="text" value="44.7577"/>	<input type="text" value="134.2730"/>
Stress (psi)	<input type="text" value="0.002"/>	<input type="text" value="0.055"/>	<input type="text" value="0.0356"/>	<input type="text" value="0.01685"/>	<input type="text" value="0.05054"/>

Figure 4.28 Statistics Dialog Box

The upper section of the window shows the statistics for the whole scan. If you have selected a region of the scan data with the mouse, the lower section displays statistics for only the selected data points.

Click on **Close** to close the Statistics dialog box.

Managing Files

Note: File operations performed in the Exicor software must have a total path length less than 256 characters.

When to Re-save Your File

Although the Exicor software automatically saves your files, you should save your file again in the following situations:

- You have added annotations to the file.
- You have corrected sample thickness value. The sample thickness should be correctly defined by the operator at the beginning of the scan. If the sample thickness setting was incorrect, it can be changed and the file re-saved.
- You want to change the sample ID and filename or move the file to a different folder.
- You want to change the stage distance units in your data file.
- You want to change the legend colors or range settings associated with the file.

Using Sample IDs

Each file saved by the Exicor software contains a sample ID (which is usually the same as the filename). The sample ID you enter when you save a file or start a scan can be up to 250 characters long. The following characters are not allowed in sample IDs:

\ * / " | : < > ?

The sample ID associated with a file is shown in the **Sample ID** field in the Exicor main window.

CAUTION

Use these tips for sample IDs to avoid overwriting existing data files:

- Enter a unique sample ID for each scan.
- Avoid renaming files outside of the Exicor GEN5 software application.

Saving a File

To save changes to a file, simply select **File→Save**. When you select **File → Save As** from the Exicor menu bar, a window pops up that is similar to other standard file save windows. Use this Save dialog box as you would any Windows Save dialog box.

The **Directory History** field remembers which folders you have saved files to so you can save files in the same folders later.

The Exicor software ensures that your data is stored even if your operating system becomes unstable. This feature is particularly important for large scans that may take several hours. Because of this, you do not normally need to take any action to save your data file. Your file has already been saved under the name of your sample ID in the current data folder.

CAUTION

Be careful not to overwrite other samples with the same name that you want to keep. This is one reason we recommend assigning a unique sample ID to each sample, or moving your sample later to a safe folder.

File Formats

Exicor software can save in 2 different formats. Both formats are readable by text readers and are easily imported into Microsoft Excel. Only the .DAT format is readable by Exicor.

.DAT Format

By default, Exicor saves data in the .DAT format. This format is readable by Exicor and text readers such as Windows Notepad. The file contains

- header data: the scan and instrument settings
- measurement data: the data points are listed in the order they were collected during the scan.

.DMT Format

This file format contains:

- header data: the scan and instrument settings
- measurement data: the data points are listed in 2 separate grids. One grid contains the retardation magnitude data. The other grid contains the fast axis angle data. The data in each grid is sorted by X,Y position.

- See Appendix C for an example of each file format.

Creating a New File

When you select **File** → **New** from the Exicor menu bar, the following happens:

- Any data and macros in memory are cleared.
- The new grid spacing setting is put into effect. Changing the grid spacing setting has no effect until you select **File** → **New** or start a new scan.
- The graph is zoomed out to show the entire stage area.

Opening an Existing File

When you select **File** → **Open** from the Exicor menu bar, the Open dialog box appears. Again, this is similar to other Windows File Open dialog boxes.

Use this Open dialog box as you would any similar dialog box under Windows. When you open an existing file, you cannot change the scan grid spacing.

If the units of the scan are nm/cm or nm/inch, you can change the sample thickness and the Exicor software will recalculate the birefringence at each measurement point. If you change the sample thickness then save the file, the file will be saved with the new sample thickness. Do not change the sample thickness unless the original thickness was incorrect.

Copying Files to the Clipboard

The Exicor software enables you to copy and paste your data graphs to other applications that are capable of accepting bitmap images. To copy a scan to the clipboard, select **File** → **Copy Graph**. The copied image contains the following information:

- Birefringence or stress plot data
- Filename and sample ID
- Legend
- Scan information: sensitivity, sample thickness, time and date, statistics, comments

The image copied to the Windows Clipboard is similar to the output produced by printing your data (see the figure below).

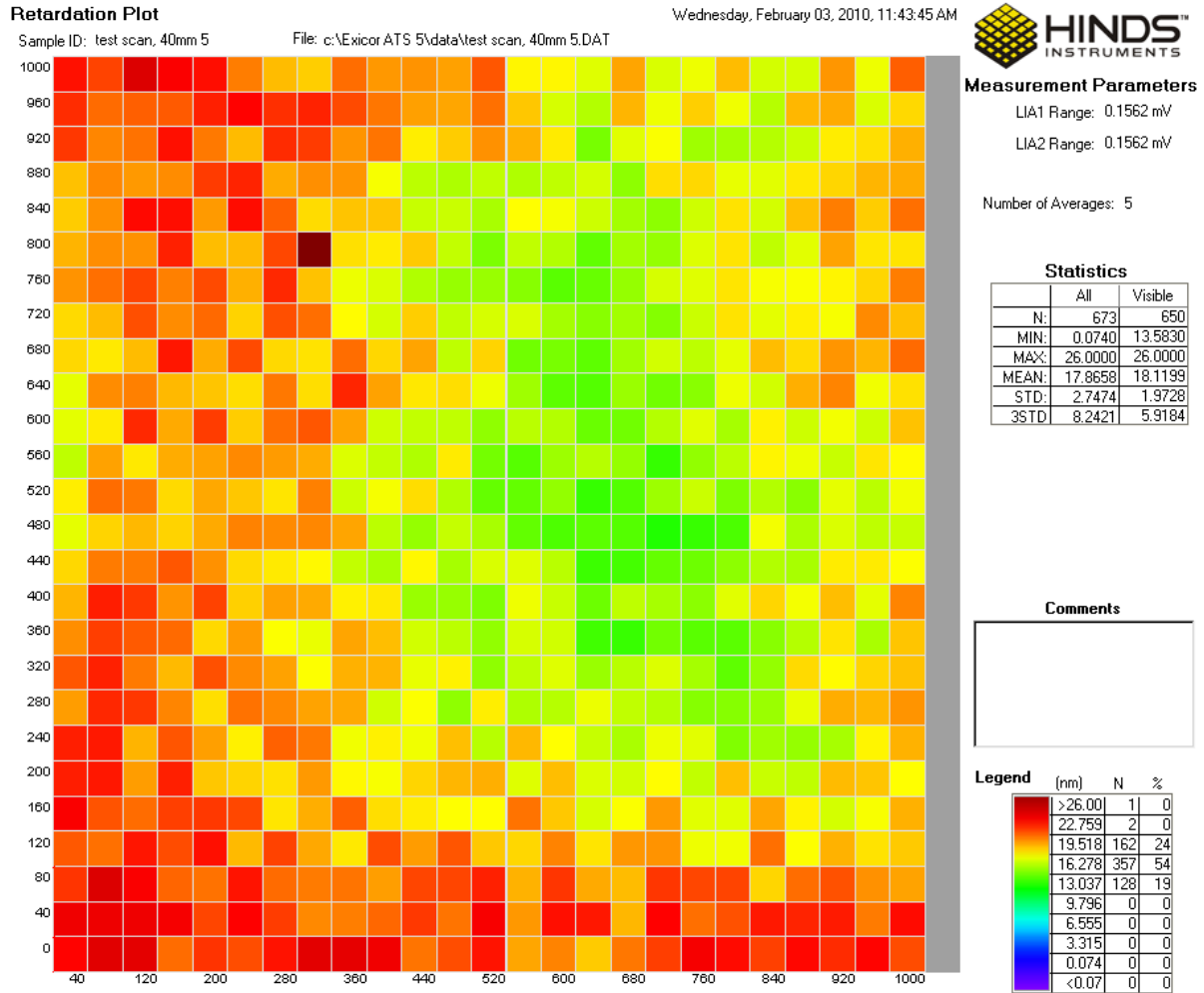




Figure 4.29 Example of "Copy Graph"

Only the currently displayed data is copied. To select the whole data set, click  before copying the scan

Printing Files

To print the data you have gathered, follow these steps:

1. Open the data file you want to print.
2. Use your mouse to select the area you want to print. If you want to zoom in on certain data points, use the  button or mouse wheel.
3. Select a graph type from the Graph to Display list.

4. Select **File** → **Print** from the Exicor menu bar. This opens the Print dialog box. Use this as you would any other Windows Print dialog box.
5. Select the appropriate printing properties in the Print dialog box.
6. Click on the OK button.

5

Using Macros

Macros are useful in the following situations:

- to define an area or multiple areas to scan that you scan often, such as several samples arranged in the same sample holder. In this situation, defining a macro once saves the time required to define the scan for each sample every time you scan. This type of macro is particularly useful in production testing where the samples are all the same size and shape (or one of a few sizes and shapes.)
- to define a range within which the sample's birefringence must fall. This can be accomplished by setting the Magnitude Min and Max set points in the defined macro. After the scan is done, you can display the data in the Pass/Fail format, showing quickly which points failed. This type of macro is particularly useful in quality-control situations.
- to easily scan irregular shapes (i.e., shapes that are not rectangular or circular.) You can accomplish this by using one of the shape tools or the **Auto Detect Aperture** button in the Edit Macro dialog box. The **Auto Detect Aperture** feature detects the outer edge of any aperture, but does not detect any blocked points within the aperture.

Creating a Macro

To begin creating a macro, select **Macro → Create Macro** from the Exicor menu bar. This opens the Edit Macro dialog box, as shown in Figure 5.1.

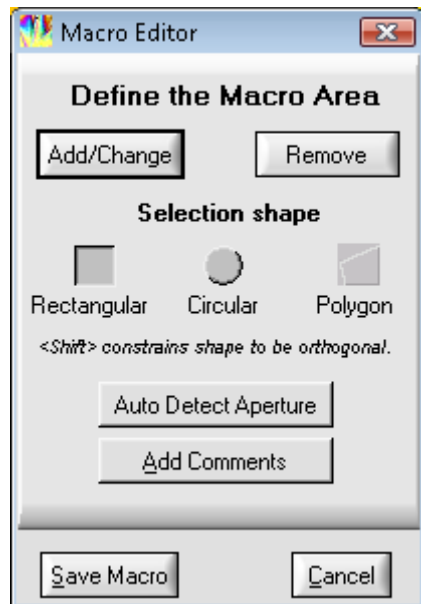


Figure 5.1 Edit Macro Dialog Box

To create a macro, follow these steps:

1. Select the type of shape to be created.
2. Go to the Automatic Scan panel and enter the desired grid spacing.
3. Use the mouse to select the first area to add to the macro and click **Add/Change**. To define a polygon, first click on the point where the first vertex should be placed. Then click to place the remaining vertices (the line expands following the mouse pointer). Then click once more on the first vertex to close the polygon.
4. To define multiple areas, press the CTRL key while drawing additional areas before clicking **Add/Change**. Alternatively, each region can be drawn individually and **Add/Change** is clicked after drawing each region to add it to the macro.
5. To remove an area from a macro, select it in the plot area as in step 3, then click on the **Remove** button. This feature can be used to cut away sections of previously added regions.

After all areas have been defined click on the **Save Macro** button. This opens a standard Save dialog box. Enter the filename of the saved macro, and click **Save**. The areas to be scanned by the macro appear as shaded regions on the 2D plot as shown in the figure below.

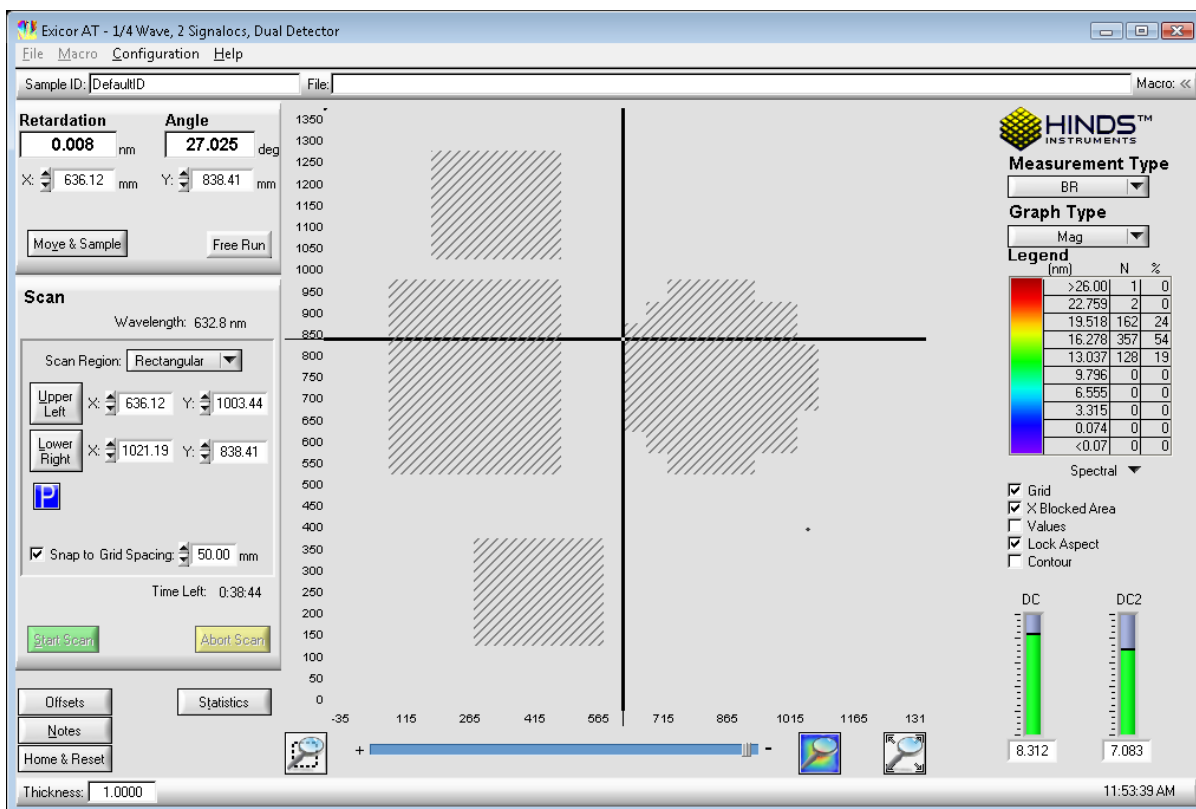


Figure 5.2 Shaded Areas Show Macro Regions to Be Scanned

Note: While the Edit Macro dialog box is open, you can still use the cursor keys to move the stage and zoom in and out using the zoom controls.

Loading a Macro

To use a macro for a scan, select **Macro → Load Macro** from the Exicor menu bar. Select the macro file you want to load and click on the **Load** button. The loaded macro is listed in the **Macro** field at the top of the Exicor GEN5 main window. This macro is used for all subsequent scans until the macro is unloaded.

Unloading a Macro

To unload a macro from memory, select **Macro → Unload Macro** from the Exicor menu bar. This clears the macro from memory, and also clears the **Macro** field at the top of the Exicor main window.

You can also clear a macro (as well as the birefringence plot area) by selecting **File → New** from the Exicor menu bar.

Editing a Macro

If you need to change a macro, first load it into memory (select **Macro → Load Macro** from the Exicor menu bar.) Next, select **Macro → Edit Macro** from the Exicor menu bar. The rest of the process is the same as for creating a macro, as discussed earlier in this chapter.

6

Maintenance and Cleaning

The Exicor GEN5 requires very little maintenance.

System Visual Check

Check periodically and whenever the system is moved or maintained, that the covers on the Sample Scanning Module are secured properly. Be certain that no unwanted laser light escapes from the enclosure.

Check periodically that interconnecting cables are free of sharp bends and cuts or abrasions.

For safety, the instrument housings should be opened only by authorized maintenance personnel.

Persons changing the cables or opening the covers on the system must:

- Remove power to the system.
- Understand the purpose, connections and voltages at each cable connection.
- Understand the hazards associated with laser light.
- Not allow eye exposure directly from laser light or any reflection of laser light from a mirror like surface.
- Understand all mechanical and electrical hazards that exist in the system.

System Performance Check

Exicor systems are delivered with a sample optic that can be used for system performance checks. The user should periodically measure this sample to make sure the system is still working properly. Follow these steps to measure the sample:

1. Mount the sample in the 1 inch diameter hole in the sample indexing corner. Rotate the sample so that the fast axis is at roughly 22°. The fast axis of the sample should be marked by lines on the top of the holder. Or in the case of a polymer film sample, the fast axis is always along the short dimension of the polymer (refer to the figure below).

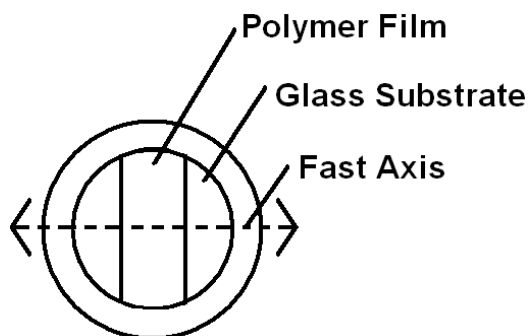


Figure 6.1 Fast Axis Orientation of Polymer Film Sample

2. Let the sample sit for at least 10 minutes. This ensures that the temperature of the sample has become steady after handling.
3. Perform a stationary scan of 100 points at the center of the sample. Be sure to take air offsets before this scan.

Compare the mean and standard deviation to the data provided by Hinds Instruments for this sample. Some variation in the mean is expected due small changes in temperature and humidity. The standard deviation should still be within the acceptable range (see the ATP document for the proper range). Also make sure that the fast axis is being reported correctly.

Determine the appropriate system check schedule that fits well with the system use schedule. A system check should be performed at least once per week but is recommended before every shift.

Consumables

Exicor systems are designed so that the downtime due to component failures is very low. The items in the system that do have fixed lifetimes are the laser and the detector filters.

The laser intensity will decrease over a period of time and the detector filters will degrade over time, resulting in decreased light transmission. The typical replacement schedule in most applications is every 2-3 years and the procedure should be done by a Hinds Instruments engineer or a factory trained representative. This schedule may vary according to the amount of time the system is powered on and the operating environment. Regular system evaluations should be performed so that the system measurement repeatability does not fall outside of the specified tolerance.

The first point of feedback for the laser and detector filter condition is the DC level at the detectors **with no sample in the beam path**. The DC levels are shown as vertical bar graphs in the main user interface (see figure below).

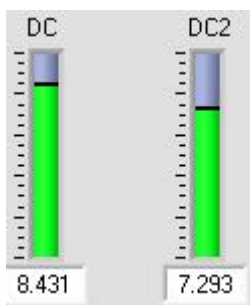


Figure 6.2 DC Level Indicator

Compare these values to the values before shipment of the system (provided on the ATP document). If either of these values falls below 1.5V, the laser and/or detector filters need to be changed. To determine if the decreased DC level is caused by the laser or detector filters, measure the laser power at the stage and compare it to the power stated on the ATP document. The laser should be replaced when the power falls below 1.5 mW. If the laser power is still above 1.5 mW then the detector filters are the probable cause of low DC levels.

Fuses

The Exicor GEN5 contains no user replaceable fuses. In the event of a system power problem, contact Hinds Instruments.

Fan Filter Replacement

The Exicor GEN5 has one cooling fan to control and stabilize the temperature of the system electronics. The inlet has a filter to keep dust and other particles out of the system. The filter is located at the front of the control system on the left side of the Master Electrical Enclosure (see the following figure).

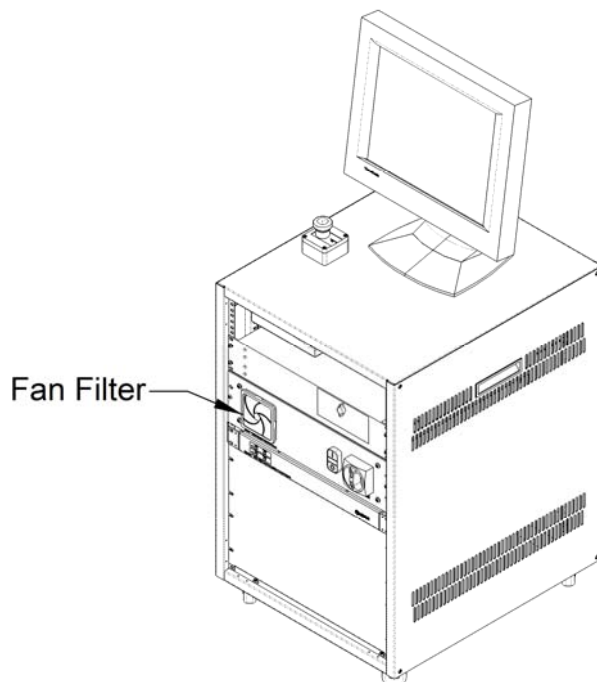


Figure 6.3 Fan Filter Location

The filter should be cleaned or replaced every 500 hours of system use. To clean the filter:

1. Use a small screwdriver to pry the filter retainer from the base of the filter
2. Pull out the filter and use compressed air to remove any dust particles that have accumulated on the filter.
3. Place the filter back on the base and put the filter retainer back in place.

Contact Hinds Instruments to order replacement filters if necessary. The Hinds Instruments part number information is as follows:

Hinds PN 330-1000-017-R - Filter Replacement, 92mm SQ Fan

Motion System Maintenance

The Exicor GEN5 system actuators require periodic lubrication to ensure proper operation and the maximum actuator life time. This maintenance should be performed with the system power OFF to prevent harm to the operator.

The recommended lubricant for all actuators and bearings is Mobil EP2 (Hinds PN: 678-0000-004).

CAUTION

Use only the recommended lubricant when performing actuator maintenance.

X-Y Actuator Lubrication

The recommended lubrication interval is every 500 hours or 5,000 km, whichever comes first. Refer to the following figures for the lubrication points and the proper lubrication tool.



Figure 6.4 Needle Point Adapter For Lubricating The X-Y Actuators

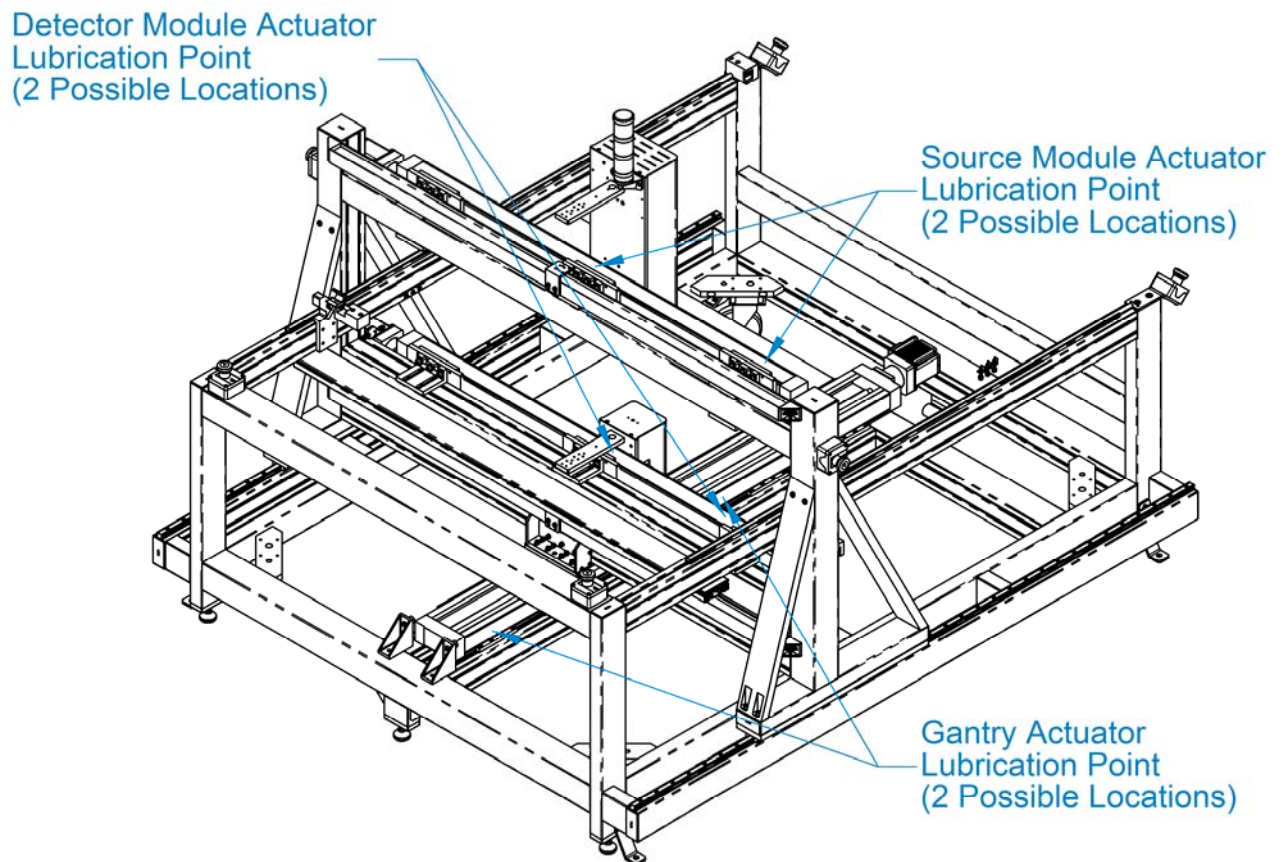


Figure 6.5 Actuator Lubrication Port Locations

Follow these steps to lubricate each actuator:

1. Remove the lubricant cap from the actuator
2. Move the carriage so that the grease fitting on the carriage is aligned with the lubricant hole in the actuator (see figure below). This will be either near the center of each actuator's travel or near the side farthest from the motor.



Figure 6.6 Grease Fitting on GEN5 Actuators

3. Attach the needle point adapter to the grease gun hose by pressing the fitting on the adapter into the socket in the hose.
4. Insert 3.6 g of lubricant into the fitting in the carriage. This step is best to perform with 2 people – one pumping the lever and one pressing the adapter into the grease fitting.
 - a. The grease gun supplied with the system will dispense 3.6 g in 4 pumps of the lever.
 - b. Make sure that the needle point adapter is pressed firmly against the grease fitting. Double-check that the grease is actually going into the fitting and not spilling out around the adapter. There should be little to no grease visible around the fitting if the grease has been inserted properly.
5. Replace the lubricant cap when finished.

Guide Rail Bearing Lubrication

The recommended lubrication interval for the guide rail bearings is once per year. See the following figures for the lubrication ports of the guide rail bearings and the appropriate tool.



Figure 6.7 Push-on Grease Fitting Adapter

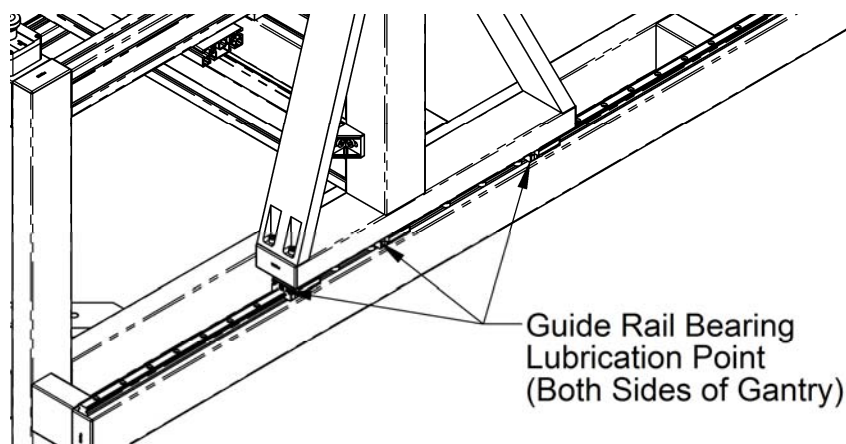


Figure 6.8 Rail Lubrication Points

The lubrication process is best to do with 2 people – one operating the grease gun and one firmly pressing the adapter onto the grease fitting. Follow these steps to lubricate the guide rail bearings:

1. Attach the push-on adapter to the grease gun hose by pressing the fitting on the adapter into the socket in the hose.
2. Firmly press the adapter onto the grease fitting of the 1st bearing block.
3. Dispense grease with 1 full stroke of the lever. Make sure the grease is actually going into the grease fitting. Grease should not come out around the fitting during this process.
4. Repeat this for all the other bearing blocks.
5. Move the gantry ~ 10 cm by pushing or pulling on the source module actuator.
6. Repeat the steps above 2 more times.

Cleaning the Optics

Under normal operation, the optics do not require cleaning. Never clean or touch the optics when the system power is ON.

If a substance such as Index Matching fluid (coupling oil) drops into the detector aperture, the oil could coat the mirror surface and cause a loss of signal at the detectors. If this occurs, clean the mirror with cotton swabs moistened with solvent. Wipe the surface gently while rotating the swab slowly. This action ensures that the contaminants are lifted away from the surface of the optic. See figure 6.4.

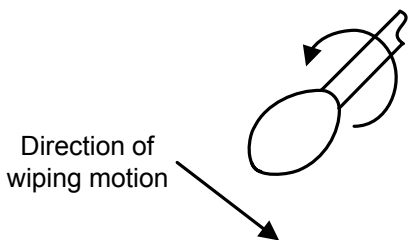


Figure 6.9 Direction of cotton swab wiping motion

Choose a solvent that will not soften or remove the locking indicator used to secure components. Isopropyl alcohol and mineral solvent are examples of suitable materials. Acetone, MEK or Toluol are unsuitable.

Cleaning the Exterior

You can clean most exterior surfaces of the Exicor GEN5 with an ammonia-based cleanser (such as Windex). Do not allow any liquids to get inside the X-Y actuators

CAUTION

To avoid electrical shock and equipment damage, do not allow any liquids to get inside the Exicor GEN5.

Do not clean the system with the power ON or while the system is plugged into the AC outlet.

7

Troubleshooting & Help

Diagnosing Common Errors

Table 7.1 lists some errors you may encounter, and suggestions on how to interpret or fix the error.

Symptom		Common Causes	Solutions
1	Start/Stop switch will not turn system on (light in center of switch does not illuminate)	Main Power Switch at Control System not switched ON EMO switch activated (button pushed in) AC power cord not plugged in	Turn ON Main Power Switch at Main Power Enclosure Pull out EMO switch button and push Start button. Plug in AC power cord
2	Lock in amplifiers (LIA) fail initialization (with system powered ON)	LIA power disconnected	Check for proper cable connections between the Master Electrical Enclosure and the Lock-in Amplifier Control Module
3	Error message: "problem communicating with the Lock in Amplifiers"	Communication cable to LIA disconnected	Check for proper cable connections between the PC and LIAs Restart software
4	Motion controllers fail initialization (with system powered ON)	Actuator control cable disconnected Communication cable to motion controllers disconnected	Check for proper cable connections at each actuator and the rear of the Master Electrical Enclosure Check for proper communication cable connections between the PC and Master Electrical Enclosure Restart software
5	Actuators will not move	Actuator control cable disconnected Communication cable to motion controllers disconnected	Check for proper cable connections at each actuator and the rear of the Master Electrical Enclosure Check for proper communication cable connections between the PC and Master Electrical Enclosure
6	Error message: "problem communicating with the motion controllers"	Actuator at travel limit	Use the cursor to move the other direction. Actuators cannot travel beyond preset factory limits Restart software

Errors		Common Causes	Solutions
7	DC level is 0 V with no sample present	The laser is not ON The light path is blocked	Check that the laser is on by putting a piece of paper in the beam path and observing the red laser spot on the paper If the laser is not ON, check the cable connection between the Source Module and the Master Electrical Enclosure Check the light path for anything that may be blocking the light from reaching the detector
8	DC level is 0 V when measuring a sample	The laser is not ON The light path is blocked Sample does not transmit light at 633nm	Check that the laser is on by putting a piece of paper in the beam path and observing the red laser spot on the paper If the laser is not ON, check the cable connection between the Source Module and the Master Electrical Enclosure Check the light path for anything that may be blocking the light from reaching the detector Observe the laser spot between the sample and the detector. If the sample scatters or absorbs the light, the sample cannot be measured by the system
9	Birefringence = -0.1 in data file		
10	Shows 'Blocked' in Retardation box		
11	Measurement point on birefringence plot is a red X or is not plotted		
12	Birefringence magnitude is large with no sample present	Offset correction not performed regularly	Perform air offset correction
13	Birefringence magnitude is larger than expected with sample present	Offset correction not performed after changing LIA sensitivity	

Errors		Common Causes	Solutions
14	Error messages: “problem communicating with the Lock in Amplifiers” AND “problem communicating with the motion controllers” AND “the program is now running in view-only mode”	Exicor software started when another instance was already running	If the Exicor software is already running on the PC, opening a second instance of the Exicor software generates these messages. The second Exicor ‘view-only’ software application can be used to view previously acquired data files but it cannot control the Exicor hardware and acquire new data. Turn off screen saver Close the new instance of Exicor software if opened accidentally
15	Software hangs during data scan	Some hardware was turned off or disconnected	Check all hardware cable connections Occasionally, the PC screen saver causes software freezes. Turn off screen saver Restart software

Table 7.1 Diagnosing Common Errors

Other Error Messages

If the Exicor software displays an error message when trying to save data to a file, check factors relevant to the error message. For example, check that the file is not in use by another program and ensure that there is enough free space on the disk to which the file is being written.

Contacting Hinds Instruments

If it is necessary to contact Hinds Instruments for support, refer to the following table for the company contact information.

Method	Information
Telephone	Monday - Friday 8:00 AM to 4:00 PM PST (503) 690-2000
FAX	(503) 690-3000
Email	support@hindsinstruments.com
World Wide Web	www.hindsinstruments.com
Shipping Address	Hinds Instruments, Inc. 7245 NW Evergreen Pkwy. Hillsboro, Oregon 97124

Table 7.2 Contacting Technical Support

When contacting Hinds Instruments for technical support, have the following system information available:

- Model name
- Serial number
- Problem symptom
- Exicor data files, .ini file, and offsets files (if applicable)

Technical Specifications

Power Requirements

The Exicor GEN5 has been configured for the power connections of the customer's factory and is designed to operate on the following:

115/230V ~, 9/4A, 50/60Hz

General Description

Exicor GEN5 is an integrated system for measuring low-level strain birefringence in thin, optically transparent samples up to 1100mm x 1300mm. An extensive system-specific software program provides the following:

- Graphical user interface
 - Automated and manual motion control of measurement modules
 - Automated data collection and analysis of samples
 - On-screen graphing of sample data or measurement data files; printable display
 - Automatic calibration check, system initialization, and system status monitoring
-

Specifications

Measurement Capability

Retardation units:	nm or nm/cm
Differential Stress units:	psi
Wavelength:	633 nm
Retardation range:	0 – 120 nm
Retardation repeatability ⁽¹⁾ :	± 0.01 nm ($Re \leq 1$ nm) or $\pm 1\%$ ($Re > 1$ nm)
Background Noise level ⁽²⁾ :	0.1 nm (without sample)
Angular repeatability ⁽¹⁾ :	$\pm 0.5^\circ$ at $Re > 1$ nm)
Measurement time:	~ 1.5 s per data point (depends on step size)

Measurement Spot size:	1 mm nominal
Maximum scan region:	1100 mm x 1300 mm

General

Software:	Exicor™ GEN (025-0000-066)
Computer System:	PC, Windows™ operating system, LCD monitor
System footprint area:	200 cm x 200 cm
System height:	170 cm
Service Access footprint:	250 cm x 250 cm (min of 250mm access on sides and back of system)
Scanning Module Weight:	~ 520 kg
Safety Feature:	Emergency OFF switches

(1) Repeatability – Definition and Test Conditions:

- Repeatability: the 3σ value from 100 sequential measurements is less than the specified repeatability value.
- System tests performed in a laboratory environment (temperature change $<1^{\circ}\text{C}$ for one hour prior to and during measurement)
- Machine is turned on for minimum of 1 hour before test with auto-offset time interval of 5 minutes
- Sample is in a fixed position
- Test sample: Polished with parallel-faces, placed orthogonal to light beam
- Sample transmissivity $> 70\%$ at measurement wavelength
- Note: Operation is possible with sample transmissivity as low as 10%; however, repeatability and accuracy are reduced under these conditions.

(2) Background Noise level – Definition and Test Conditions

- Definition: the average of 100 sequential measurements with no sample in the light beam
- System tests performed in a laboratory environment (temperature change $<1^{\circ}\text{C}$ during for one hour prior to and during measurement)
- Machine turned-on for minimum of 1 hour before test with auto-offset time interval of 5 minutes
- System tests performed in a laboratory environment (temperature $20 \pm 1\text{C}$)


Software Features

- Manual control of birefringence measurement (measure single point)
- Automated system control of birefringence measurement (scan multiple points on an area)
 - User adjustment of scan area and grid spacing
 - Calculates scan time required
- Detects that actuators have moved to the correct position without errors
- Macros
- Create Pre-set scan patterns
- Define scan regions for multiple samples

Graphing

- Plot options:
 - Color plot of retardation magnitude, with or without angle vector plot
 - Differential stress
 - 3D surface plot
 - Contour plot indicating regions of birefringence magnitude
- Save and print: graphs and numeric readouts with user commenting capability
- Copy and paste graph to MS Office applications
- Zoom In/Out via buttons or mouse wheel

User Features

- Copy file name from start scan dialogue
- Abort button
- Real-time measurement display updates
- Data saved in .DAT or .DMT files using plain text tab-delimited format
- Park button  for sample loading

B

Exicor[®] GEN5 Limited Warranty

Hinds Instruments, Inc. warrants the Exicor[®] GEN5 Birefringence measurement System to be free from defects in materials and/or workmanship for (1) year from the date of delivery, subject to the provisions contained herein. Hinds' warranty shall extend to the original purchaser only and shall be limited to factory repair or replacement of defective parts.

Exclusions

This warranty does not cover consumable parts, normal maintenance or damage resulting from improper use or repair, or abuse by the user. This warranty extends only to repair or replacement, and shall in no event extend to consequential damages. In the event of user repair or replacement, this warranty shall cover neither the advisability of the repair undertaken, nor the sufficiency of the repair itself.

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This warranty gives you specific legal rights, and you may also have other rights that vary from state to state.

Warranty Service

If you find any defects in material or workmanship or any failure to meet the specifications, you must notify Hinds within the warranty period and obtain a Return Material Authorization Number (RMA#). This can be done by calling Hinds Instruments at 1-800-688-4463, or by emailing our [service department](#). Return the product to us in proper packaging, freight and insurance prepaid, and clearly marked with the RMA#, and we will either repair or replace it, at our option.

Non-Warranty Repairs

If a product that is not covered by the above warranty needs repairing, we will first provide an estimate of repair charges and then repair the product upon receiving authorization from you. Repairs are warranted for ninety (90) days from the date of delivery.

Reference section 7 (Troubleshooting & Help) on page 75 for contacting technical support.



HINDS INSTRUMENTS, INC
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