EXICOR® 300AT

BIREFRINGENCE MEASUREMENT SYSTEM

USER MANUAL

Hinds Instruments, Inc.
P/N: 010-0000-067 UM Rev A

EXICOR® 300AT

B I R E F R I N G E N C E M E A S U R E M E N T S Y S T E M

USER MANUAL

Hinds Instruments, Inc.
P/N: 010-0000-067 UM Rev A

Software Version ATS 6.24

Exicor® is a registered trademark of Hinds Instruments, Inc.

The Exicor 300AT is covered by the following US patents:

U.S. Patents: (1) 6,473,179, (2) 6,697,157, (3) 7,002,685

China Patents: (1) ZL02820533-2

Japan Patents: (1) JPN 4616746, (2) JPN 4629869

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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 and rear of the system. See #1 in Figure S.1.

⚠ WARNING

MOVING PARTS PRESENT
Can result in serious injury due to pinch or crush.
Keep away during operation.
Disconnect and lockout power before servicing.

P/N 095-2600-011
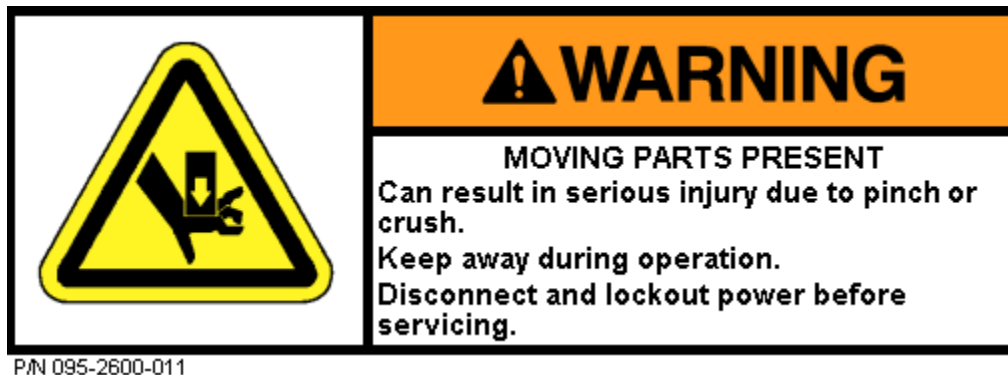
The wording on this label is:

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 following IEC/EN Logotype label is placed on the top surface of the X-Y stage. See #2 in Figure S.1.

CAUTION

LASER LIGHT
AVOID DIRECT EYE EXPOSURE

5 mW AT 633 nm

CDRH CLASS IIIa LASER PRODUCT
IEC/EN CLASS 3R LASER PRODUCT

The wording on this label is:

Caution, Laser Light. Avoid direct eye exposure. 5mW AT 633 nm. CDRH Class IIIa laser product. IEC/EN Class 3R Laser Product.

The system is marked with the following Protective Housing label on the source module cover. See #3 in Figure S.1.

CAUTION

CLASS 3R LASER LIGHT WHEN OPEN
AVOID DIRECT EYE EXPOSURE

The wording on this label is:

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

The system is marked with the following Laser Light label on the source module cover. See #4 in Figure S.1.

AVOID EXPOSURE
Laser Light is emitted
from this aperture

The wording on this label is:

Avoid exposure, Laser light emitted from this aperture.

The X-Y-Motion Stage is marked in two places with the following Pinch Point label. See #5 in Figure S.1.

The wording on this label is:

Caution pinch point.

The system identification label below is placed on the rear of the Scanning Module. See #6 in Figure S.1.

The wording on this label is:

Model No. _____, Serial No. _____, Manufactured: _____.
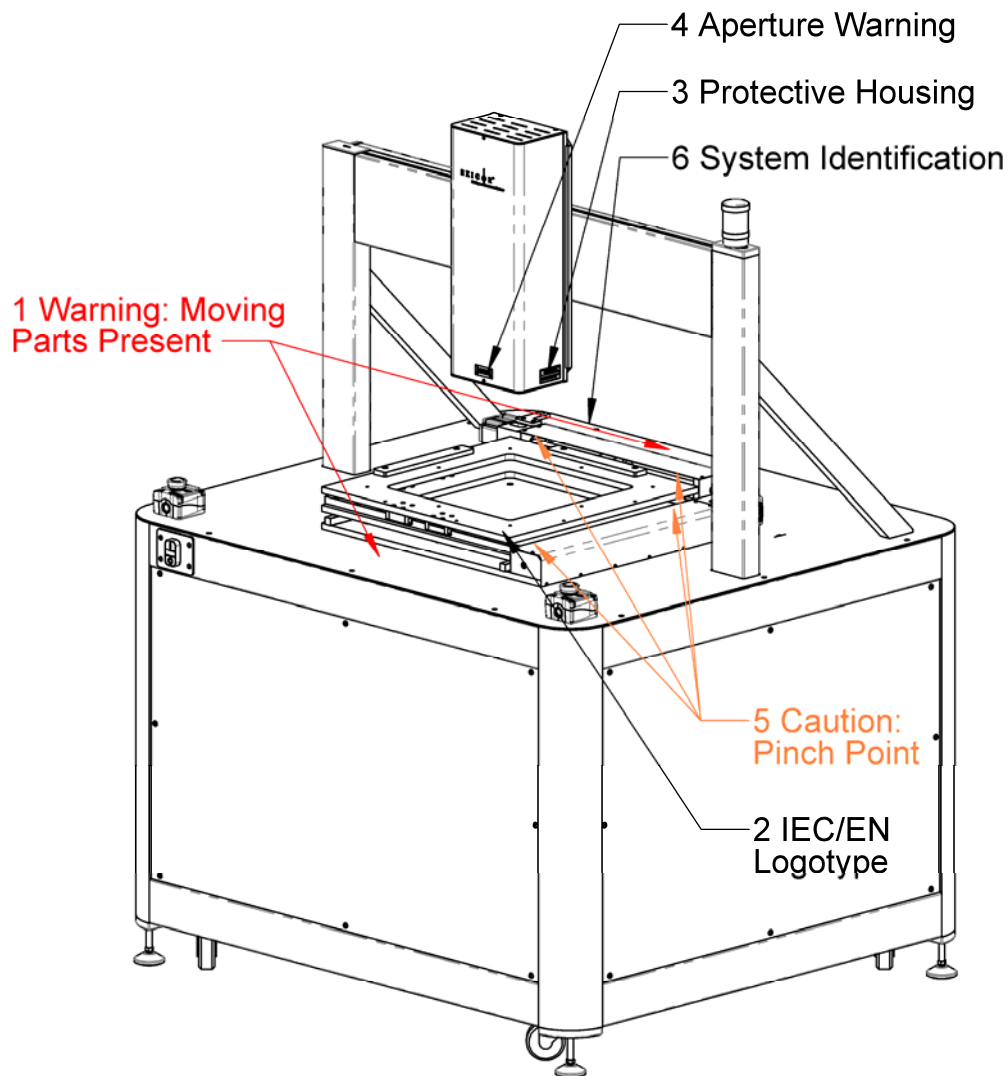
Figure S.1 Compliance Labeling

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:

> 100-240VAC, 50/60Hz, 3A MAX

Use the Proper Power Cord

Use only the power cord and connector specified for your product to work with your local power outlets. Use only a power cord that is in good condition.

Do Not Operate without Covers

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

Laser Safety

The light source contained in the Sample Scanning 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 Sample Scanning Module, after attenuation by the polarizer and the PEM, is typically less than 3.2 milliwatts (mW.)

The maximum power output directly from the laser, between the laser and the first optical element, is 5 mW at 633 nanometers (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 page 2.

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. Opthalmol, Vol. 118, Dec. 2000, Dennis M. Robertson, MD, et al., Dept. of Ophthalmology, Mayo Clinic, Rochester, Minn.
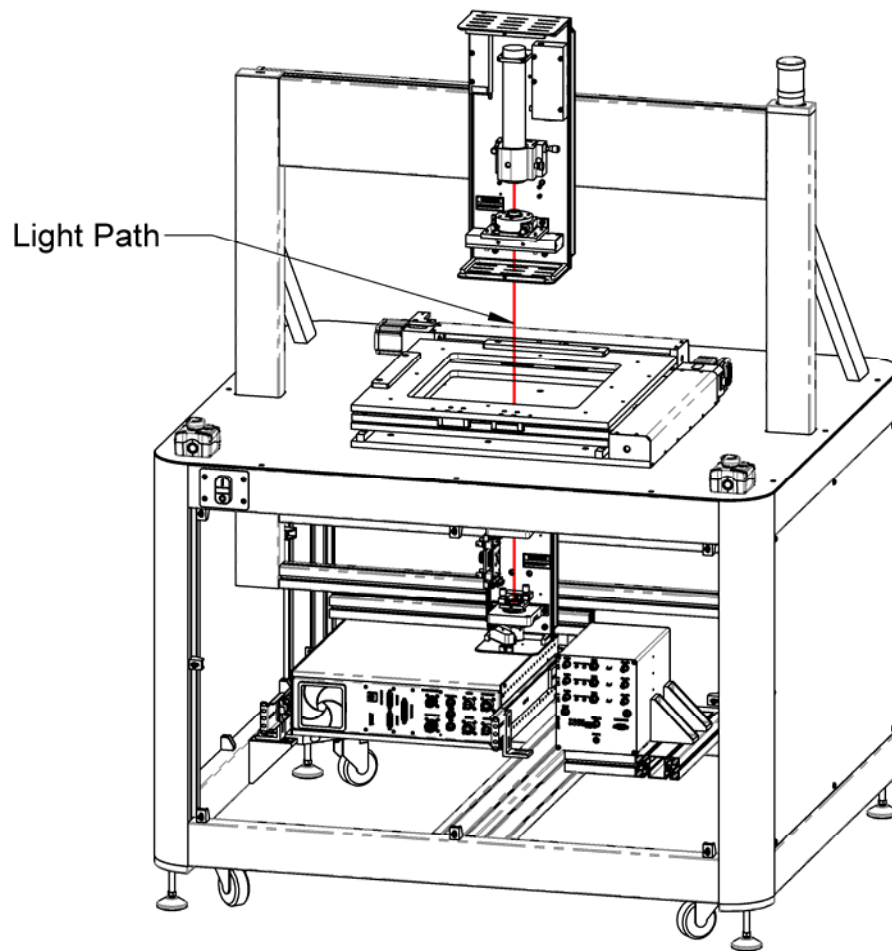
Figure S.2 Laser Beam Path

Mechanical Safety

Avoid contact with the X-Y Stage when it is in motion. Motion of the stage occurs during system initialization, sample scans, and by various controls within the user interface. Turn off power to the Exicor 300AT when replacing or making changes to the sample holder.

Electrical Safety

Rear panel outlets carry low voltage signals. Typical voltages are 0 to 4 volts with none exceeding 24 volts.

The Exicor 300AT contains no user-serviceable components. Refer any maintenance or adjustment needs to Hinds Instruments, Inc or an authorized distributor.

Do not allow any liquids to get inside the equipment.

Emergency OFF Switch

The Exicor 300AT has 2 Emergency OFF (EMO) switches. The switches are located at the front of the Scanning Module table top. 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.3 shows the location of the Emergency OFF switches.
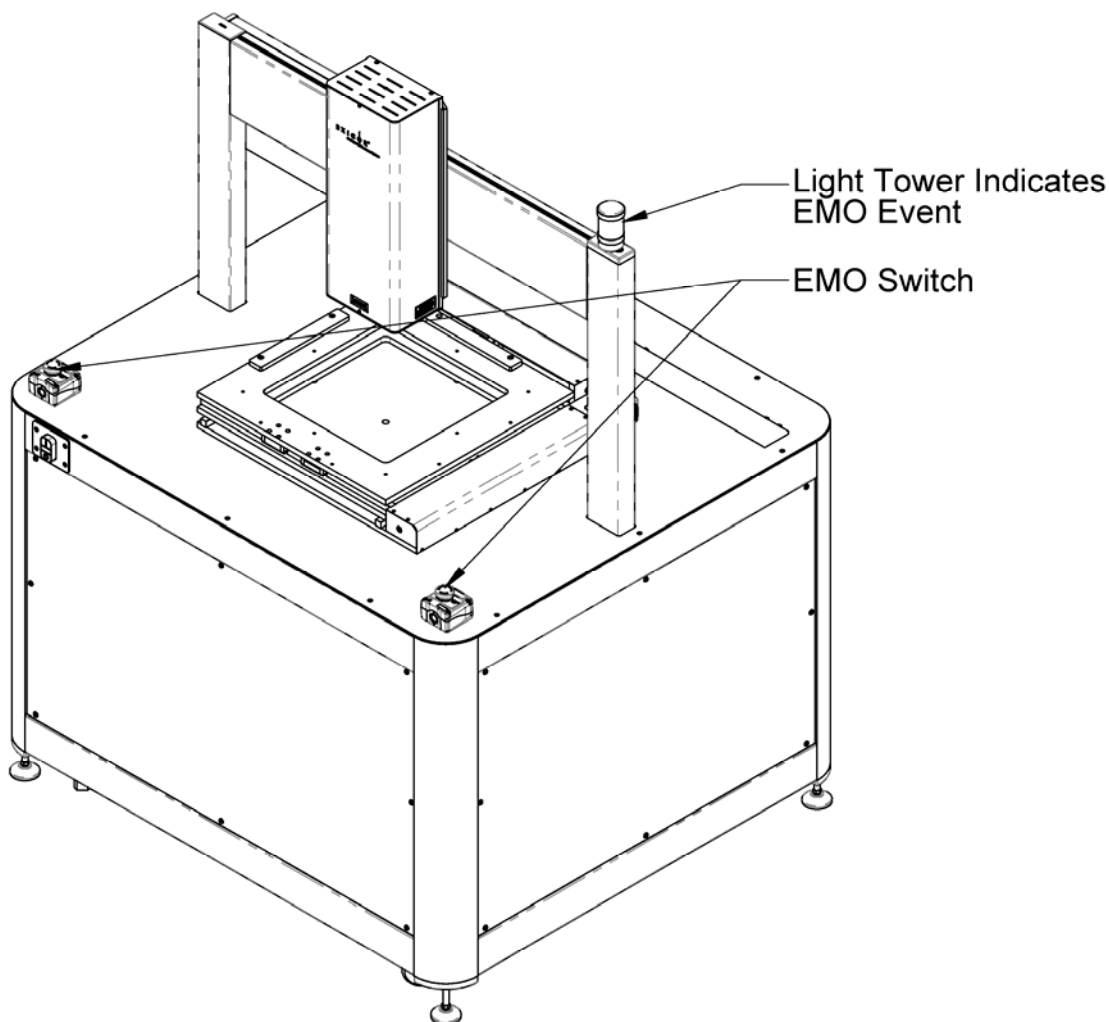
Figure S.3 EMO Switch Locations

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 Scanning Module. Activating the EMO system will not harm the Exicor 300AT.

Activating the EMO system **will not** remove power to the computer, 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 300AT, first clear the condition that prompted the EMO button to the pushed. Once the condition is made safe for the user and equipment, the EMO button should be rotated to deactivate the EMO switch.

Rotating the EMO button out **will not restart the system**. After the EMO button is rotated, the Exicor 300AT can be reactivated by pressing the green 'ON' button on the front of the system (see figure 1.1).

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 300AT will not turn ON until all EMO buttons are rotated to the OUT position.

If the system will not turn ON after an EMO event, check that all EMO buttons are rotated so the switch head is extended.

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

1

Overview of the Exicor 300AT Birefringence Measurement System

The Exicor 300AT birefringence measurement system is an easy-to-use highly sensitive instrument for measuring the fast axis orientation and low-level magnitude of linear birefringence in flat, parallel-surface optical materials. The system can also give an estimation of the differential stress present inside the sample (optional). An automated X-Y stage is used to move the sample in order to measure different locations to create a "map" of these measurements.

The system is available with two different measurement ranges:

1. ¼ wave – measures low birefringence samples at high sensitivity. Measurement range is 0 – 120 nm.

2. ½ wave – better for measuring higher birefringence samples but with less sensitivity for the low retardation samples. Measurement range is 0 – 316 nm.

Other options include:

- Scan In Motion (SIM) – drastically reduces measurement time for most samples by taking data while the X-Y stage is moving.

- Zones Scan – allows easy scanning of multiple samples located in the same sample holder. This feature is compatible with SIM.

Exicor 300AT Birefringence Measurement System Description

Listed below are the main components of the Exicor 300AT birefringence measurement system. See figures 1.1 and 1.2 on the following pages.

- **<u>Scanning Module:</u>** Includes the components for generating the modulated light beam, detecting the light as it exits the sample, and demodulating it at high sensitivity. The scanning module also includes mechanics for holding and precisely moving the sample. The individual components are:

  - **Source Module**

    - o He-Ne Laser – provides 633nm light beam.

    - o 50 kHz PEM – Provides controlled modulation of the beam polarization state before the sample.

  - **Detector Module**

    - o ¼ wave system – 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.

    - o ½ wave system – A 60 kHz PEM further modulates the light before being detected by a single detector.

  - **X-Y Stage** – Provide a means of moving the sample so that the light beam passes through the sample at different points.

  - **Signal Processing Unit** – Demodulates the detector signal, communicates the signal information to the computer, and provides signals to control PEM modulation and detector gain

    - o **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.

    - o **High Speed Data Buffer** – The Hinds Instruments data buffer makes repeatable high speed measurements possible. The data buffer synchronizes communications with the lock in amplifiers and accurately times the measurements on either an internal clock or external input (for SIM only).

- **<u>Computer and Exicor Software:</u>** Controls the system hardware, movement of the sample, calculates the results of each measurement point, and manages data files.
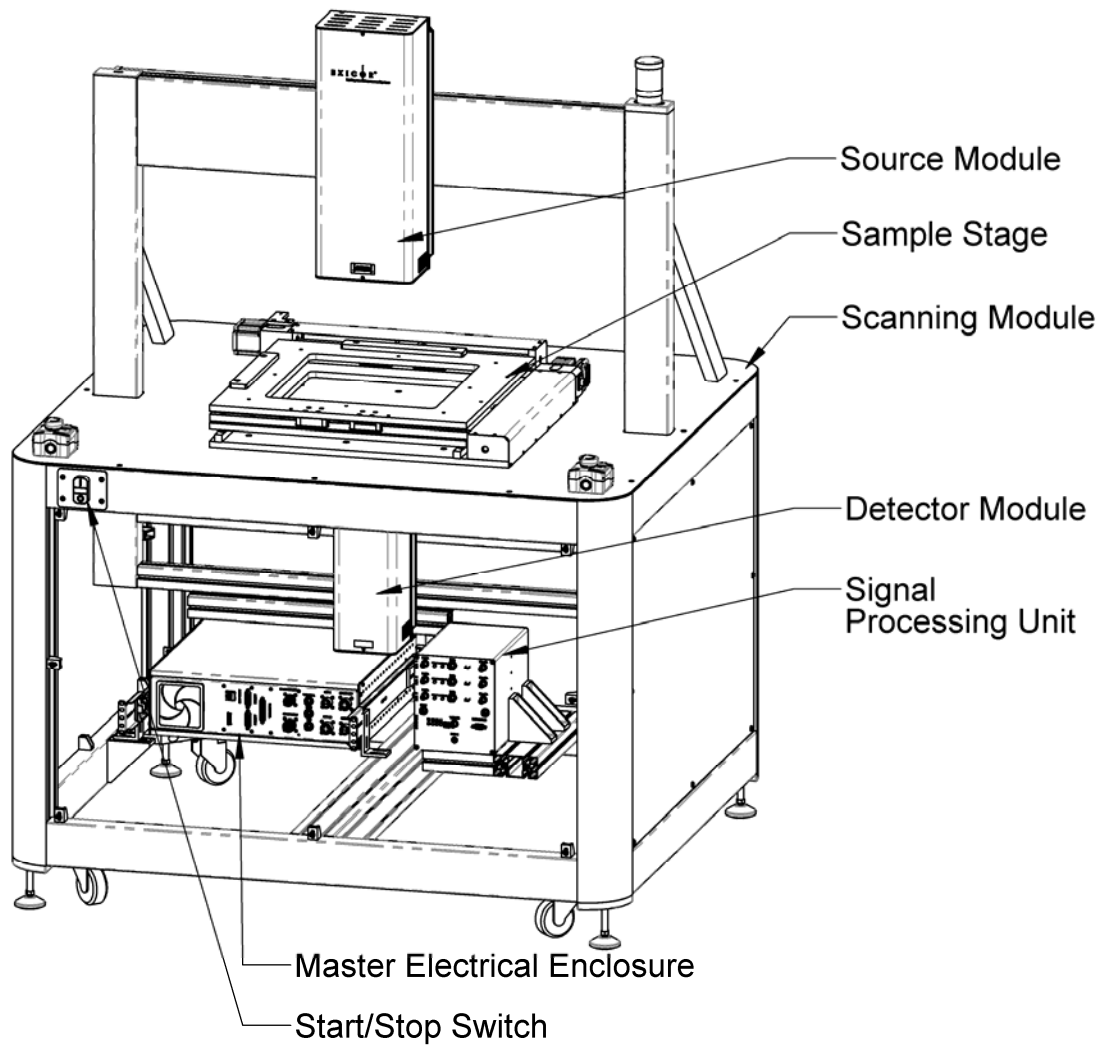
Figure 1.1   Exicor 300AT Main Components
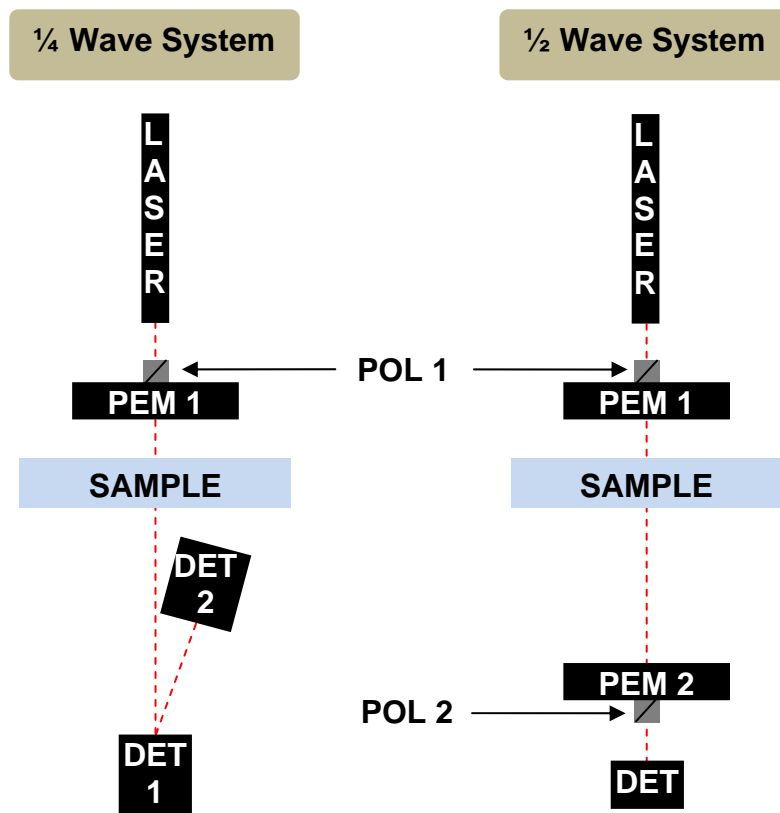
Figure 1.2 *Optical components of ¼ wave system and ½ wave system*

General Dimensions

DIMENSIONS: cm

175

127

113
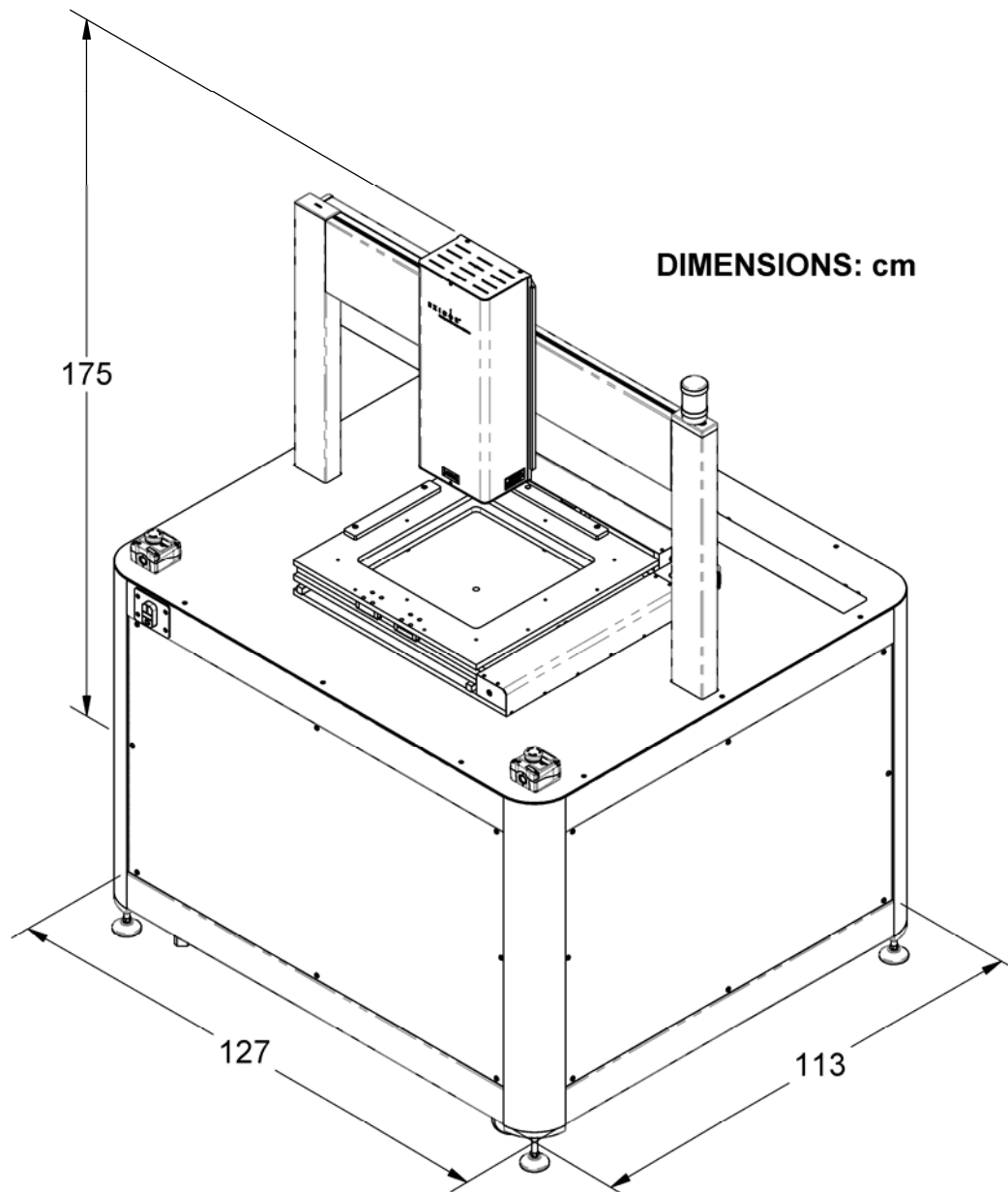
Figure 1.3 General Dimensions

2
System Operating Requirements/Setup

Component Placement

The computer and monitor need to be placed within 2 meters of the scanning module to facilitate connection of all hardware control cables.

The scanning module relies on natural convection for cooling the interior components. There are vent holes on the rear of the system that allow heat to escape from the interior. The scanning module must be placed such that airflow from the rear panels is not restricted. In order to facilitate the maintenance and servicing of components, do not place the scanning module within 1 meter of a wall in any direction.

Power Connections

The Exicor 300AT 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 is not necessary.

The Exicor 300AT includes a high quality surge protector that is designed for the customer's voltage supply. This surge protector will be connected to the scanning module, computer, and monitor. Therefore, only 1 power outlet is required for the system.

Turning the Exicor 300AT ON and OFF

The main power switch for the Exicor 300AT is located on the rear panel of the scanning module. Rotating the switch to the ON position will allow AC power from the wall to enter the Master Electrical Enclosure (MEE). This switch has a lockout feature to be used during system maintenance.

Once the main power switch is in the ON position, start the system by pushing the green button on the start/stop switch; this will power up all system devices. The start/stop switch is located on the front of the scanning module. 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 300AT was delivered with a computer using the Microsoft Windows operating system. The Exicor software application is installed at the factory prior to shipment.

Calibration

The Exicor 300AT 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.

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

3
Operating The System

System Initialization

To initialize the Exicor 300AT system:

1. Press the **green** button on the start/stop switch.

2. Launch the software program by double-clicking 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.
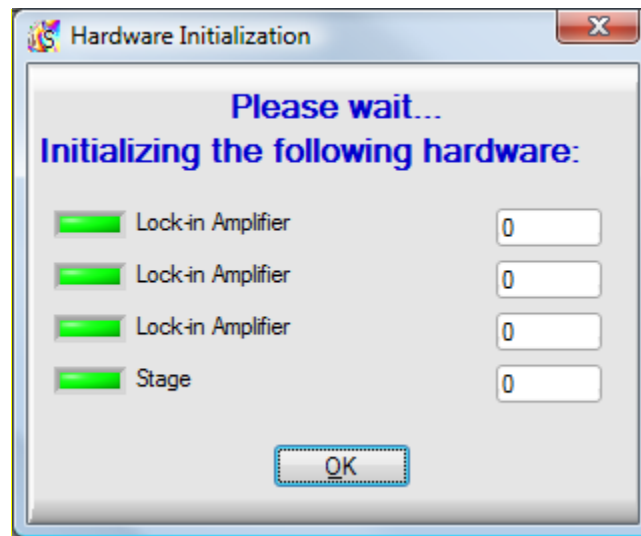
Figure 3.1 Hardware Initialization Screen

During hardware initialization, the user will notice the following:

1. The data buffer and lock-in amplifiers will initialize.

2. The sample stage will move to find its home position and then move to a user-defined offset location (if used).

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

If an error occurs during the initialization phase, identified by a red indicator, see Chapter 6 for help dealing with system initialization errors.

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.

Offset Measurements (Zeroing the System)

In order to maintain the low level measurement accuracy and sensitivity, the system must be "zeroed" periodically. For this process the system analyzes the detector signal with no sample or other obstructions in the beam path and uses this condition as a base line for future measurements.

The appropriate time period for taking offset measurements will vary by application. If very low retardation samples are being measured (retardation < 5 nm), it is recommended to take offsets before each scan and every 20 minutes thereafter in most cases. If high retardation samples are being measured, the time between offsets can be longer.

There are 2 options for taking offset measurements: manually and automatically. Both methods require the beam to be unobstructed during the process. To take a manual offset, simply move the stage so that the laser beam is not obstructed and click . The automatic offsets function will always take an offset before each scan then periodically take offsets during the scan as well. To take offset measurements automatically, the user must define the settings of the auto-offset measurements as described on page 37.

Loading a Sample

Load a sample onto the system by placing it in a special holder to be mounted to the top plate of the X-Y stage. Sample holders can be fixed to the stage using the threaded holes provided in the top plate.

See Figure 3.2 below for the dimensional information and mounting features of the X-Y stage.

DIMENSIONS: mm

Sample Holder Locating Edge

225.0

400.0 350.0

225.0

M6x1.0 THRU
8X

Beam Path Aperture

Customer Sample Holders
Mount on This Surface

350.0

400.0

12.7 MAX Sample
Holder Depth
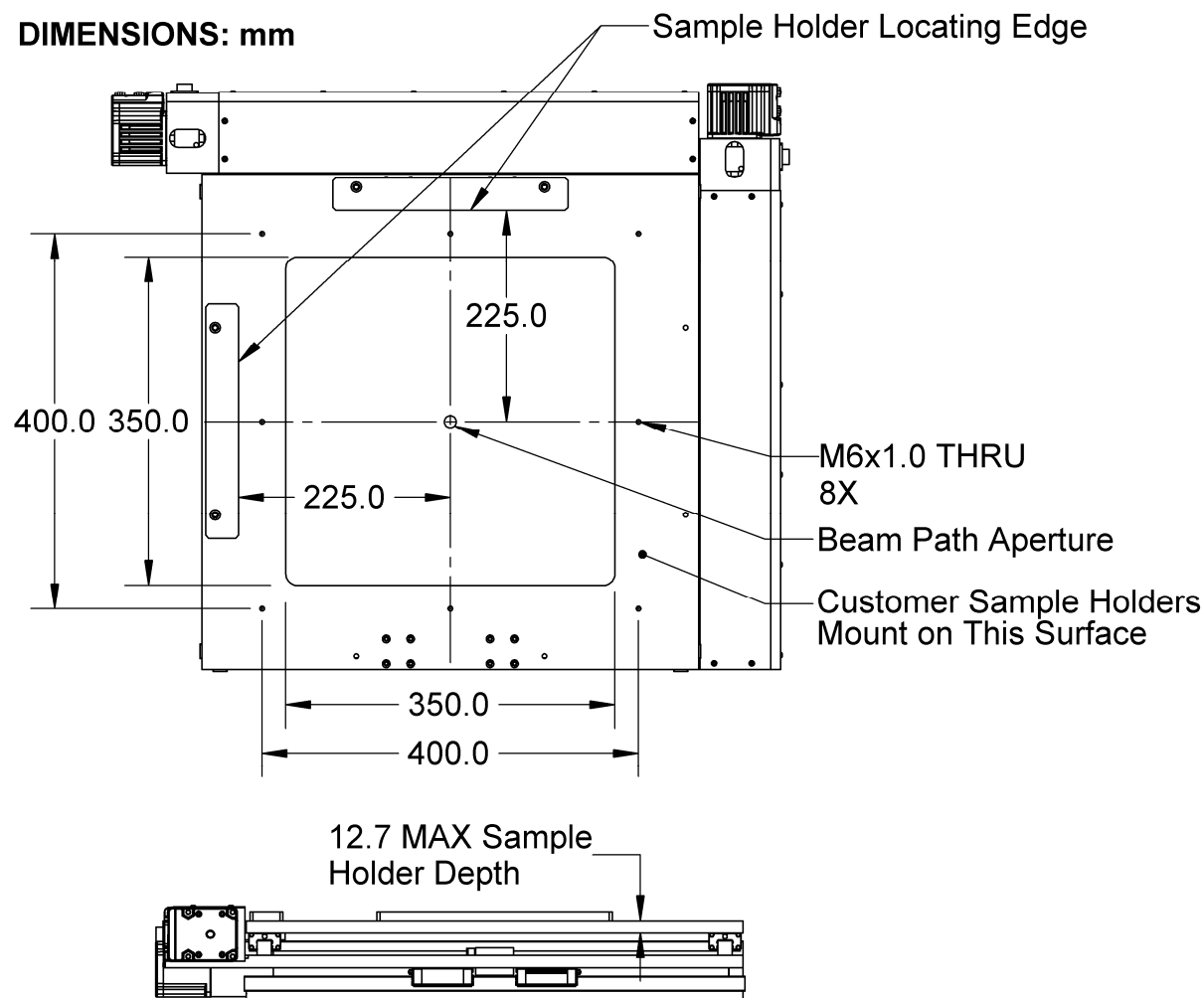
Figure 3.2 Sample Stage Top Plate

Note: It is preferable to wait at least 10 minutes before measuring samples after handling in order for the sample to reach thermal equilibrium. Handling the sample can change its temperature temporarily, which may also affect the birefringence measurement. The wait time may be different for samples of different sizes.

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 3.3. The main window may show different controls depending on the options purchased with the system.
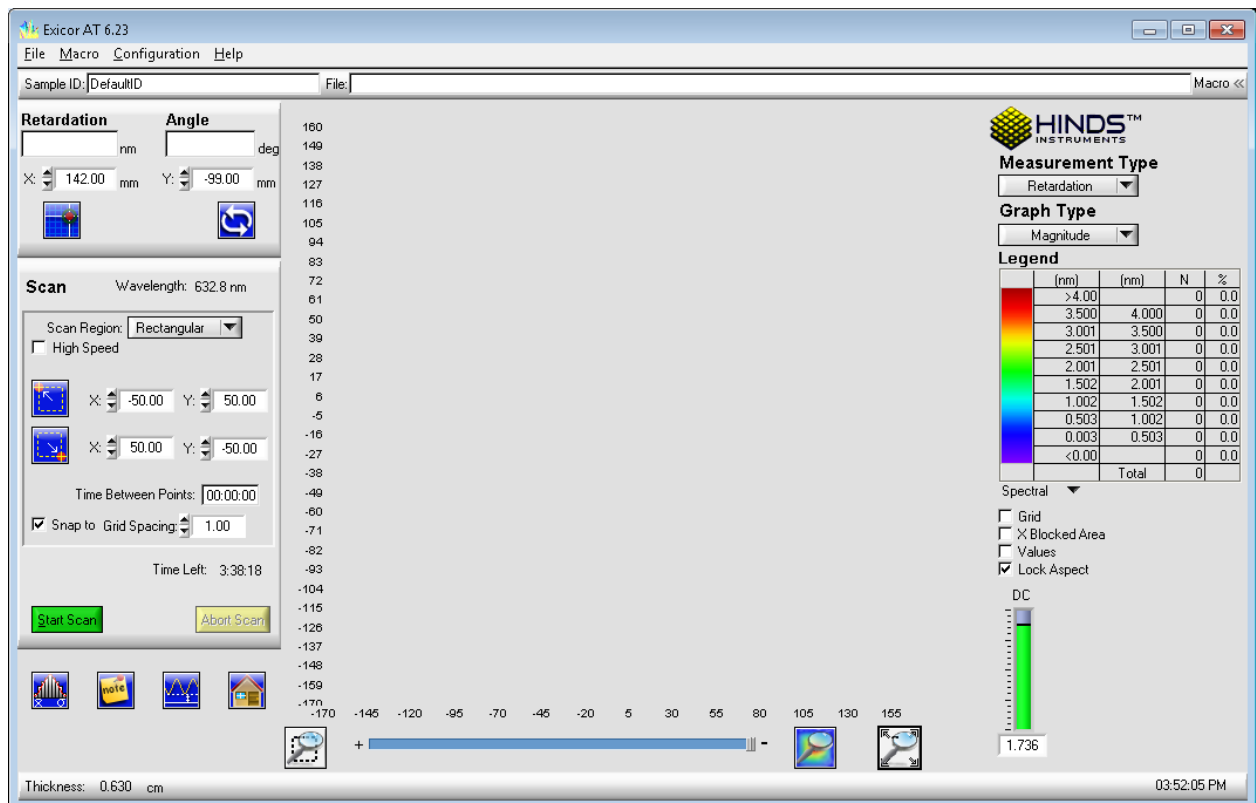
Figure 3.3 Exicor Main Window at Startup

2. Take an offset measurement

    - move the stage so that the light does not pass through the sample but goes straight through to the detector.

    - Click the ![button] 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.

    - Alternatively, offsets can be set up to happen automatically. See page 37 for more information.

3. Select **Rectangular** in the **Scan Region** drop-down menu.

4. Define the parameters of the scan

- Enter the grid spacing to be used for the scan in the **Grid Spacing** field. This is the increment size that the X-Y stage will use when moving the sample. Push **TAB** to apply the grid spacing change.

- Rectangular areas are defined by an upper left corner and a lower right corner. Click on the upper left point of the desired scan in the plot area of the software, drag down to the lower right point of the desired scan area, and release the mouse. See Figure 3.4 for an example of scanning a 100 x 100 mm scan area. Alternatively, enter the coordinates of the upper left and lower right coordinates of the scan area in the fields provided.

- Click the **High Speed** checkbox to do a high speed scan if desired (SIM option only)
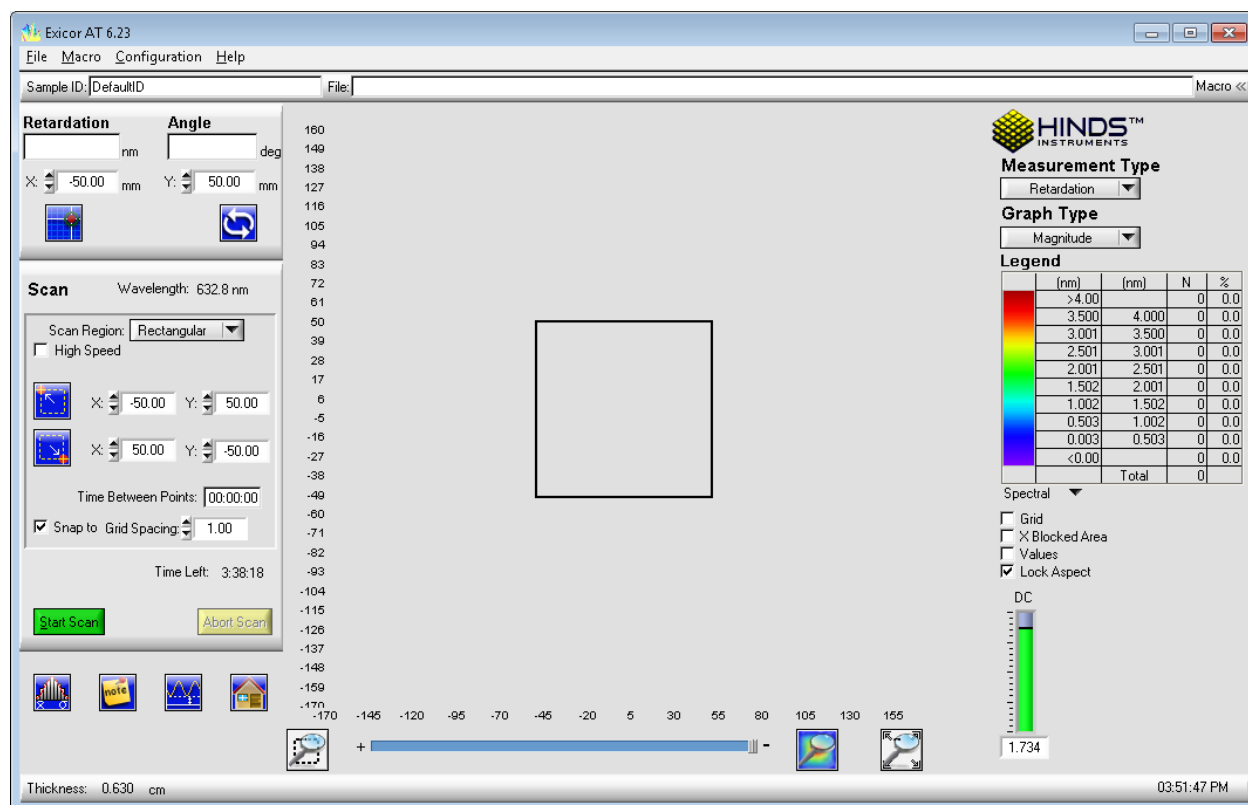
Figure 3.4 Setting up a 100 X 100 mm scan

5. Click on the **Start Scan** button. A new window pops up, prompting the user for a "Sample ID" (file name) and file location. Change the sample ID and file location as necessary. If the Sample ID field is left blank, the default sample ID "DefaultID" will be used.

NOTICE

The software uses the sample ID as the filename. If you do not choose a unique name, any existing file with the same name will be replaced with the new scan.

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

Once the scan starts, the data points will begin to appear as each point is measured as shown in Figure 3.5. These are the measurement results.
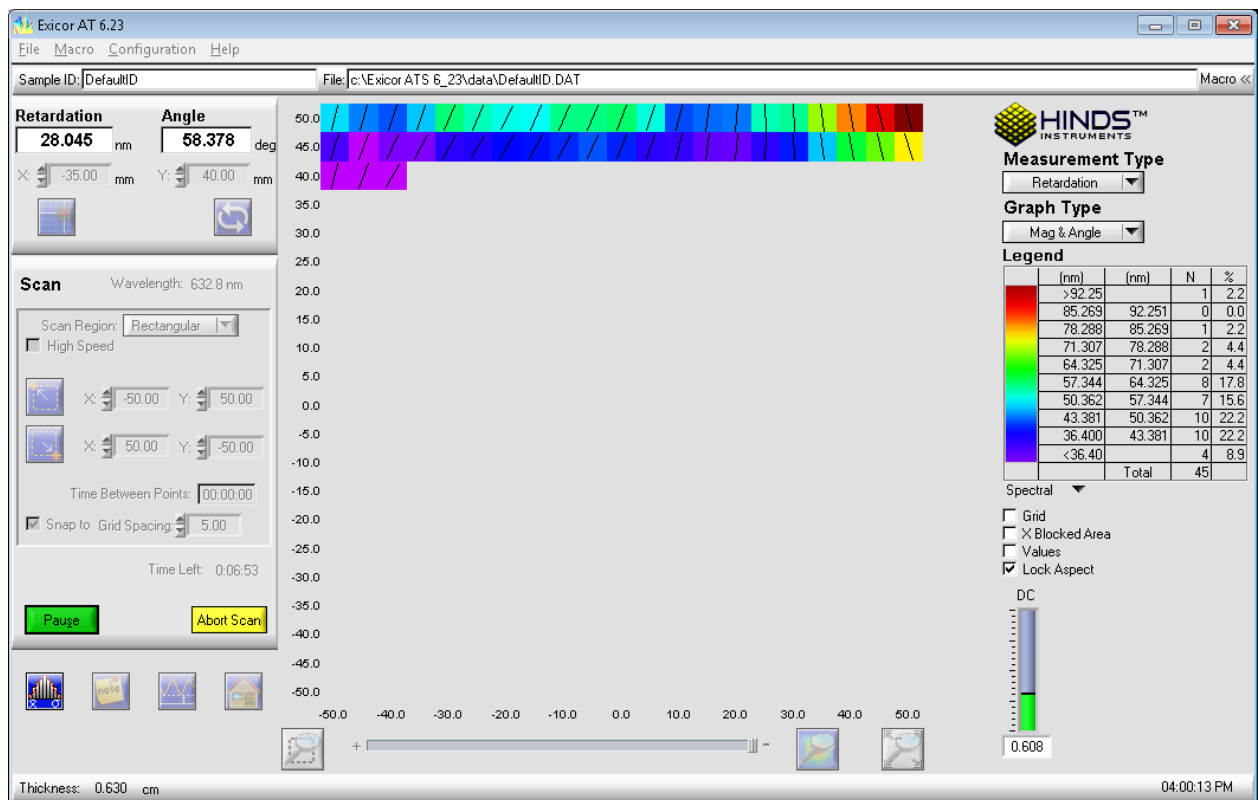
Figure 3.5 Rectangular Scan In Progress

If desired, the legend colors can be changed by double-clicking on the Legend panel.

When the scan is complete, x-y stage movement stops and the measurement plot area shows the complete results of the scan, as shown in Figure 3.6.
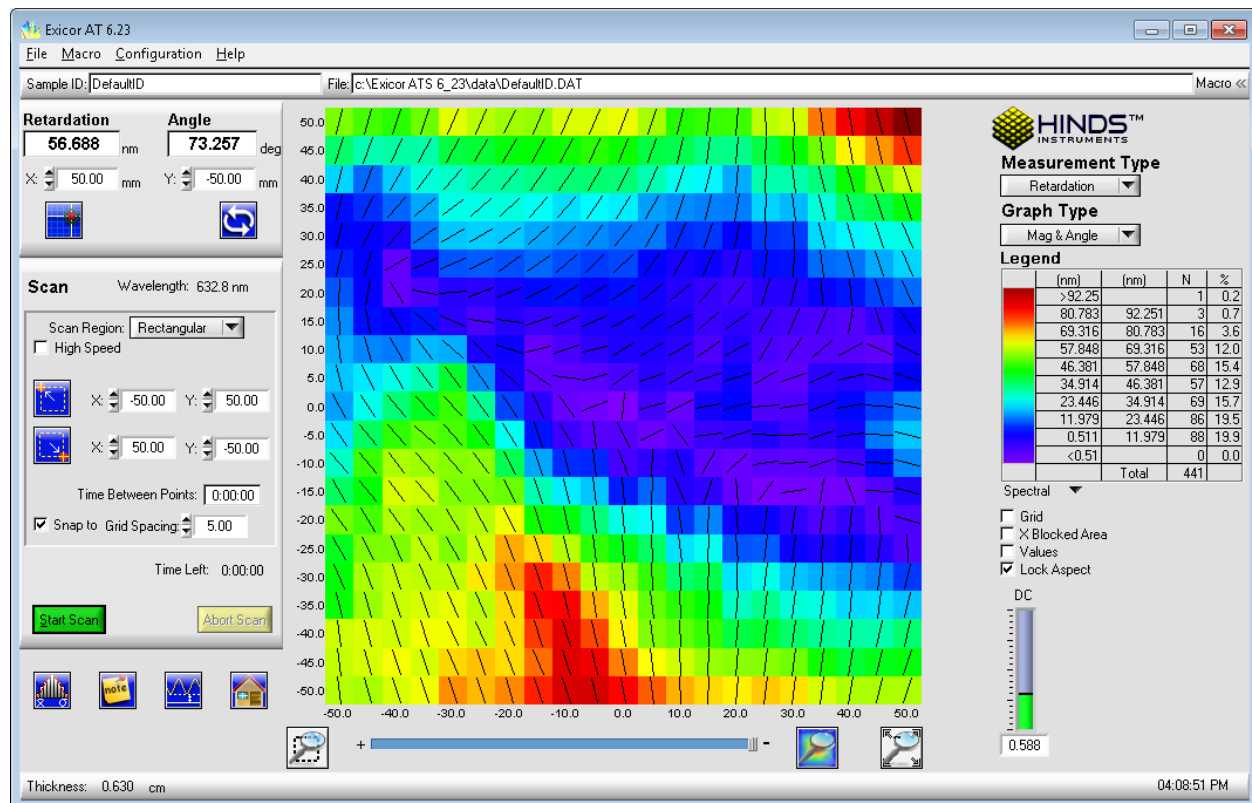
Figure 3.6 Completed Rectangular Scan

The data has been stored automatically under the Sample ID that was entered before starting the scan. The file is of the format "SampleID.dat" which is readable by Exicor software and also easy to import into spreadsheet applications.

To scan another sample of the same size using the same scan settings, mount the new sample and click on the **Start Scan** button. Enter a sample ID and click **OK**. The process repeats with the new sample. If the next sample to scan is a different size or shape, steps 3 – 6 above need to be repeated for the new scan area.

If a new sample ID is entered for the second sample, the software will automatically store the results to a new data file**. If the default sample ID is used, the new data replaces any data currently stored in the file "DefaultID.dat".**

The steps above 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 it is not necessary to complete it, press the **Abort Scan** button. This will end the scan at the current measurement point and save the data collected up to that point.
2. Close the Exicor software.
3. Push the **red** button on the start/stop switch. All devices inside the scanning module will shut down. The PC and monitor can be shut down independently if 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 software interface. The measurement plot, which is the graphical display of the scan data, appears in the central plot area. The information on the plot depends on the measurement type and graph type 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 sections of the Exicor main window are shown in Figure 4.1 on the following page.
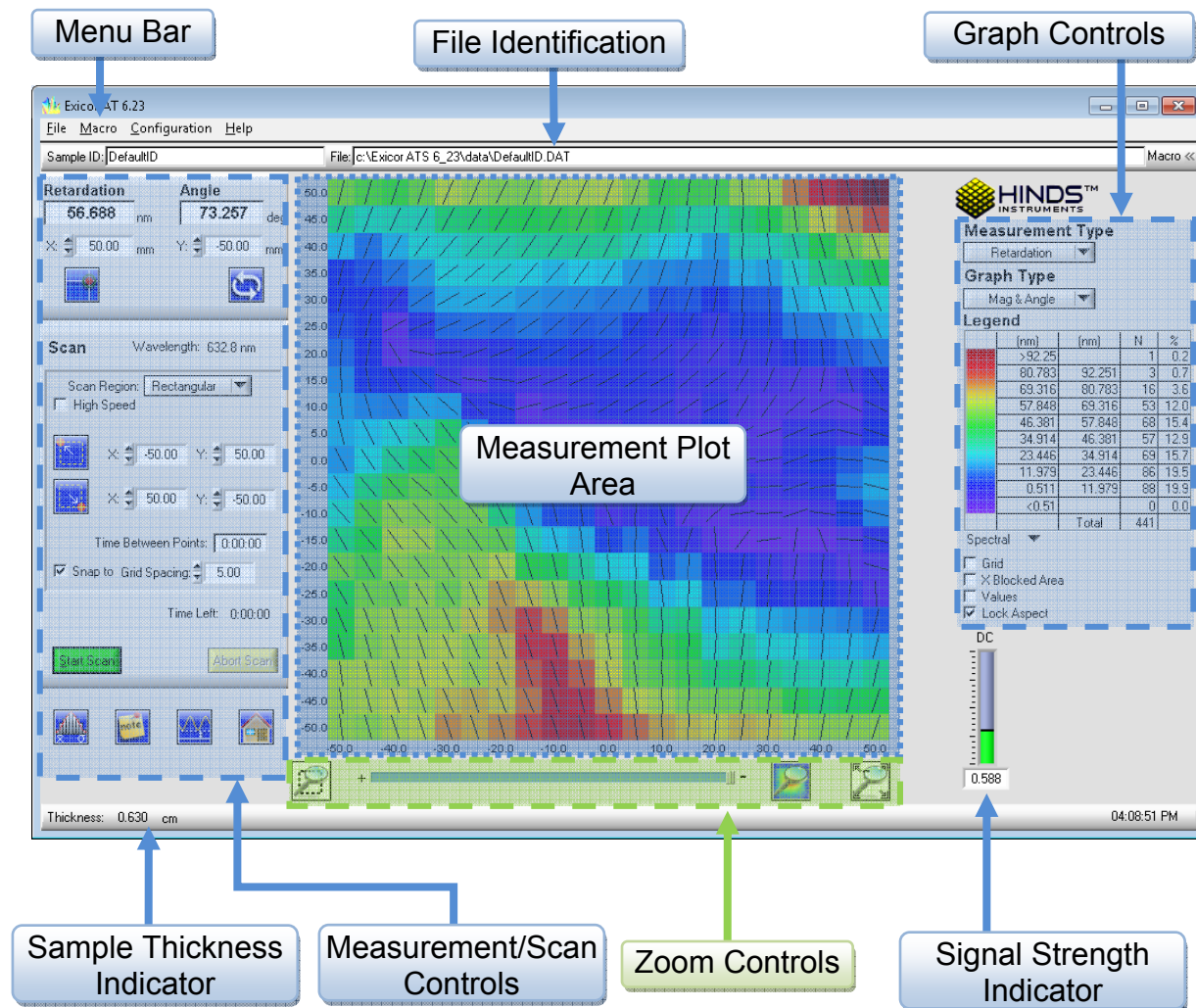
Figure 4.1 Exicor Main Window Description

Menu Bar

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

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.

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

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

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

File Identification Bar

The **Sample ID** field displays the sample ID associated with the open file.

The **File** field displays the name of the current data file. File opening and saving progress is indicated by a green status bar that appears in the file field.

The **Macro** field displays the macro currently loaded. See page 60 for information on using macros.

Interactive Scan Panel

Figure 4.2 shows the Interactive Scan panel, located at the upper left-hand side of the Exicor main window.
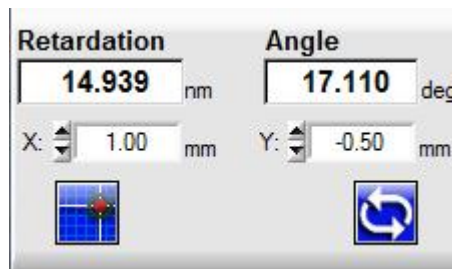
Figure 4.2 Interactive Scan Panel

The Interactive Scan panel is used for single-point measurements only. See Making Birefringence Measurements on page 41 for scanning an area.

Automatic Scan Panel

Figure 4.3 shows the Automatic Scan panel, located at the left-hand side of the main window under the Interactive Scan Panel.

This panel is used to define the geometry of the scan. See Automatic Scans on page 43 for more information.
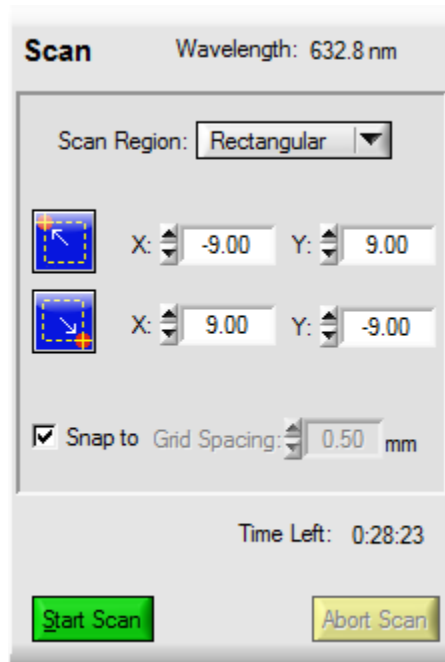
Figure 4.3 Automatic Scan Panel

Birefringence Plot Area

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

Using a mouse, the user can select a grid point to display the measured data in the Interactive Scan panel. Clicking and dragging with the mouse will select a region on the plot window. This region can be used to define a region for a new scan or zoom

Other Displays and Controls

Figure *4.4* shows the strength of the detector signal (DC). 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. .

Figure 4.4 DC Level Indicator

The functions of the buttons below the Automatic Scan panel are explained in the following table:

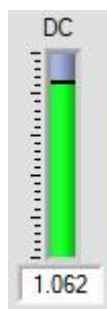| Icon	Name	Description
	Statistics	Shows the measurement statistics of the current file loaded. Selected areas in the plot window are shown separately at the bottom of the window.
	Notes	Add/view comments to the current data file.
	Offset	Performs a single point measurement at the current x-y position to use as a baseline for sample measurements. There should be no sample in the beam path when measuring the offset.
	Home & Reset	Reinitialize the hardware. Use this button if the measurement system is not responding or fails to perform measurements.

Table 4.1 Statistics, Notes, Offset, and Home & Reset buttons

The status bar at the bottom of the main window shows the sample thickness indicator. This is the sample thickness that has been entered by the user. It is important to have an accurate sample thickness in order to get an accurate calculation of the birefringence and stress. The retardation will be accurate even if the sample thickness is wrong. The sample thickness in the status bar is for display only and can be changed in the **System Parameters** window.

Configuring the System

Many aspects of the scanning process can be adjusted by changing various values and settings. Use Table 4.2 as a quick reference when changing system parameters.

This Parameter/Function	Is Accessed Here
Grid Spacing	Main Window or **Configuration →System Parameters → Settings**
Offsets	 or **Configuration → System Parameters → Offsets**
Number of Averages	**Configuration →System Parameters → Settings**
Lock-in Amplifier Sensitivity	**Configuration →System Parameters → Settings**
Sample Thickness	**Configuration →System Parameters → Settings**
Stage Distance Units	**Configuration →System Parameters → Settings**
Stage Home Position Offset	**Configuration →System Parameters → Settings**
Enable Auto Calibration	**Configuration →Auto-Offset Settings**
Auto-Calibration Location	**Configuration →Auto-Offset Settings**
Num Offset Samples	**System Parameters → Offsets** OR **Configuration →Auto-Offset Settings**

Table 4.2 Summary of Where to Change System Parameters

System Parameters Window

To access the System Parameters dialog box (all tabs shown in Figure 4.5 below), select **Configuration → System Parameters** from the Exicor menu bar.
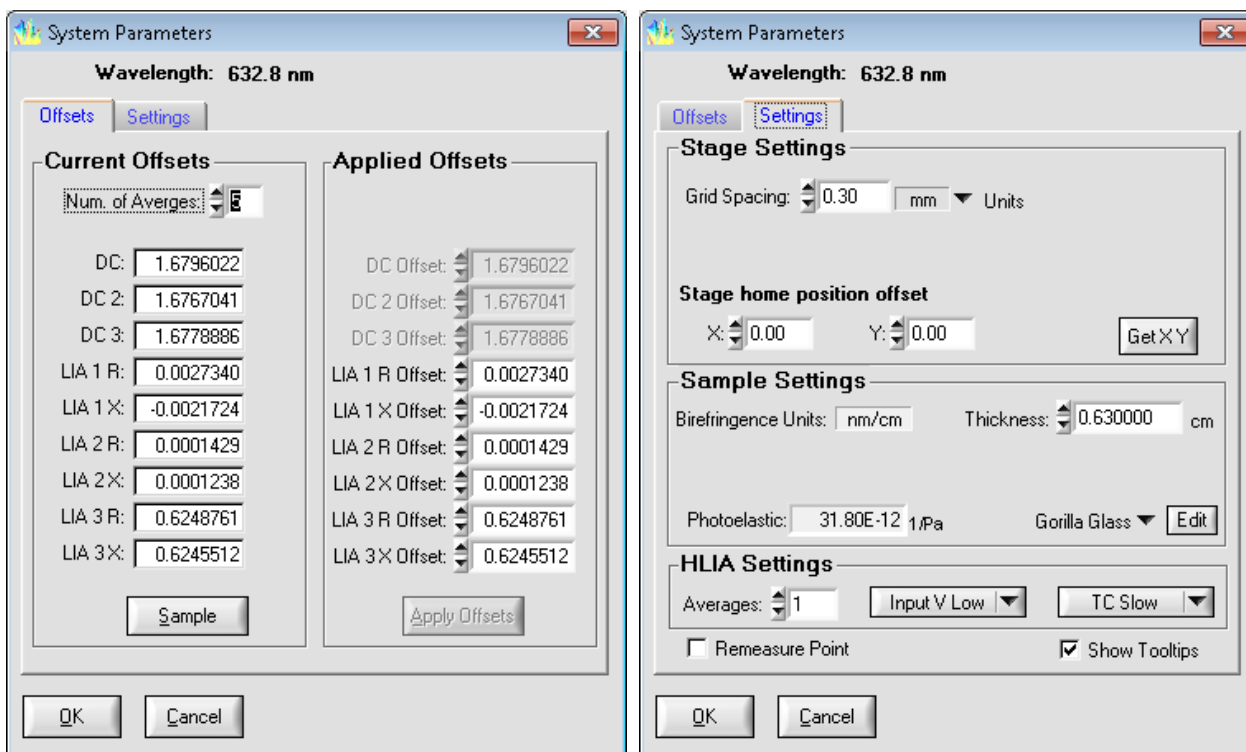
Figure 4.5 System Parameters Dialog Box

Offsets Tab

The functions on the **Offsets** tab are described below.

Measurement Offsets

Click the **Sample** button to take an air offset. Make sure that there is no sample material or other obstruction in the beam path. Once the offset measurement is complete, click **Apply Offsets** to complete the operation. **This** function is the same as clicking the icon on the front panel except that when offsets are taken on this panel, the values are displayed. This is sometimes helpful for troubleshooting measurement issues.

Num. of Averages refers to the number of offset measurements that will be taken in succession and averaged together to be used as the offset value. Change the value if necessary in the field provided. The default value is 5 and the user does not need to change it in most cases.

Settings Tab

The functions on the **Settings** tab are described below

Changing the Stage Distance Units

To change the distance units used in the plot area of the main window, select a different unit via the `mm ▼ Units` drop-down menu.

The available stage distance units are:

millimeters (mm)
centimeters (cm)
When the stage distance units are changed, 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.

Grid Spacing

The grid spacing is the spacing between measurement points of the area scan. It is also used as the motion step increment when moving the sample stage with the cursor keys. To change the grid spacing, enter a new number in the **Grid Spacing** field and push the Tab key. The grid spacing can also be changed by entering a new value in the **Grid Spacing** field on the main window.

When the grid spacing is changed, the current data file is unloaded, the plot area is cleared, and the plot scale is updated to use the new spacing.

Stage Home Position Offset

The stage home position is the location used as the origin (0,0) for X-Y stage motion. To set the current stage position as the home position, click **Get X Y**. Alternatively, enter the desired coordinates in the **X** and **Y** fields then click **OK**.

Sample Thickness

The sample thickness is used by the software to calculate birefringence and stress. These calculations will not be accurate if the sample thickness has not been entered for the sample to be scanned. The Retardation measurement is accurate even if the sample thickness has not been entered correctly.

Photoelastic Constant

The photoelastic constant is necessary for calculating the differential stress in the sample. This value must be accurate in order to get an accurate calculation of the stress. To change the value, choose a new material from the drop-down menu. The material property list provided with the system is just an example. New materials can be added using the **Edit** button next to the drop-down menu.

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. If desired, enter a new number into the **Averages** field.

> **Note:** Measurement averages is set to 1 (no averaging) automatically in High Speed mode.

Sensitivity

This control sets the voltage range that is used by the lock-in amplifier for acquiring the detector signals. In general, low birefringence samples result in small signals on the lock-in amplifiers and high birefringence samples result in large 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.

For low retardation samples, more repeatable measurements can usually be obtained by setting the sensitivity to **Input V Low**. In general, the **Input V Low** setting will work well for samples up to 30 nm. If the sample birefringence creates a signal that is out of the range of the lock-in sensitivity, an error message will be displayed in the Retardation field of the main window. If this occurs, set the LIA sensitivity to **Input V High.**

Time Constant

The time constant is the internal averaging time that the Signaloc™ lock-in amplifiers use when acquiring the detector signal. In general, a higher time constant will result in less noisy measurements but a longer overall measurement time. The opposite is true for lower time constants. The appropriate value has been set at the factory prior to shipment and should not need to be changed by the user. If the time constant must be changed, choose a new value using the drop-down menu and click **Apply**.

The time constant is automatically set to the minimum value when High Speed is active.

Auto-Calibration Settings

The Auto-Calibration feature is used to perform measurement offsets automatically before and during a sample scan. In order to use auto-calibration, the system needs to have access to a "no sample" location even while the sample is loaded. This location should have no sample material or any other obstructions. To access the Auto-Calibration settings, select **Configuration→Auto-Calibration Settings** from the menu bar.
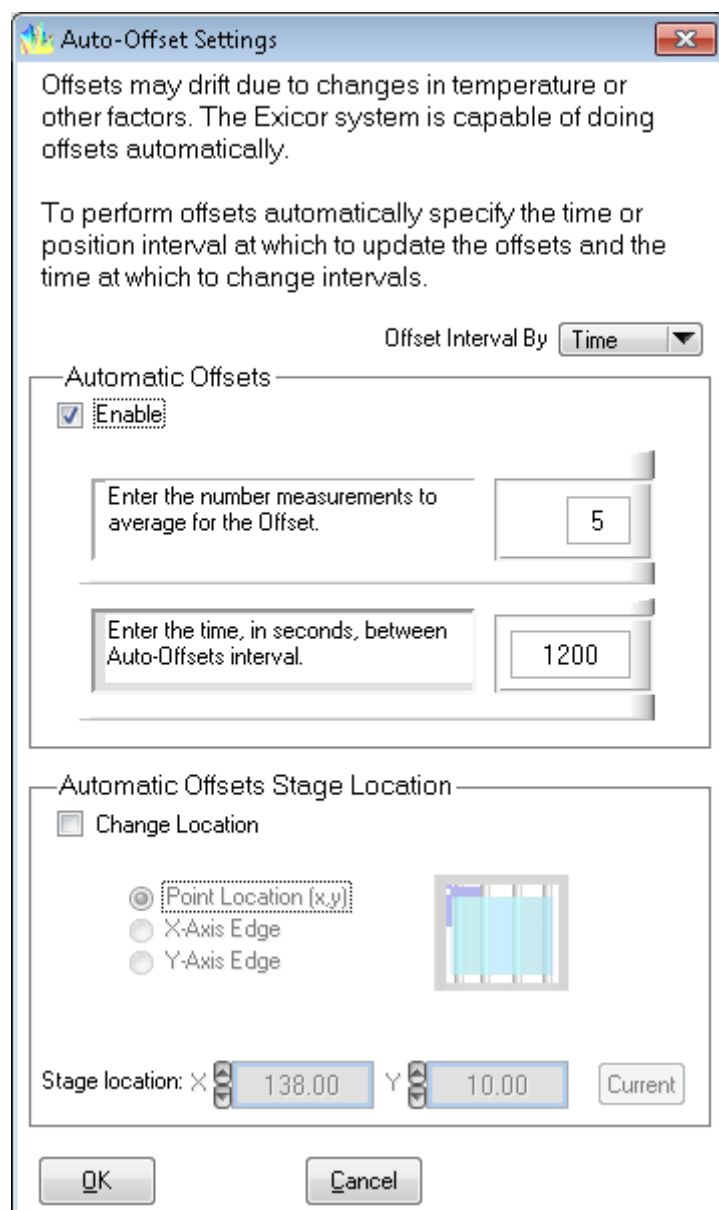
Figure 4.6 Auto Calibration Settings Dialog Box

In order to access the auto calibration feature, check the **Enable Auto-Calibration** box. Auto-offset settings are defined in 2 ways:

1. By Time: take offsets on a time interval
2. By position: take offsets based on X-Y stage position

To change the number of single measurements averaged together for the auto-calibration measurement, enter a new number in the field provided.

The most useful way to do offsets on the Exicor 300AT is by time. The position method is more useful for other Exicor models. Both methods are described below.

Offsets by Time

When offsets are measured on a time basis, the system will take a measurement offset before each scan then periodically during the scan. To use auto-calibration on a time basis, select **Time** from the drop-down menu.

To change the time between offset measurements (during the scan), change the value in the field provided (units: seconds).

To change the location for the automatic offset measurement, select **Change Location**, edit the values for the x,y coordinate of the offset measurement.

> **Note:** The auto-calibration location must be a position on the sample stage where no sample is present and the beam is unobstructed (not blocked). Once set, click **OK** to save settings.

With the default settings as shown in the figure above, the system will make 5 offset measurements and average them together for the air offset. It will do this every 20 minutes (1200 seconds) during each scan.

Offsets by Location

The location-based method for measuring offsets uses the position of the stage to determine the location and interval for offset measurements. The offsets are not all taken at the same location. They are taken in relation to the sample edge. To change the type of location-based offsets, check the **Change Location** box and select the desired method. The 2 methods to define location-based offsets are described below:

Sample X-axis Edge

This offset method will measure air offsets every time the X,Y position approaches a sample vertical edge that is defined by the user.

To make the left side of the scan the offset side, change **Stage Location X** so that it is in a clear area (no sample, no obstructions) beyond the left side of the sample. Every time the X-Y stage approaches the end of a line while moving left, it will move off the sample and take an offset at the X location that has been entered and the current Y location. For this offset method to work, the entire line defined by the X location entered and the Y distance of the scan must be unobstructed. The offset location must be at least 5 mm past the edge of the sample.

To make the right side of the sample the offset side, define the **Stage Location X** to be beyond the right side of the sample. This method will work the same as described above for the left side, except that it will happen on the right side.

Sample Y-axis Edge

This method works similar to the "Sample X-axis edge" method described above. This method, however, makes offset measurements beyond the top or bottom edge of the sample, depending on the Y location entered. Change the sample offset edge by changing the **Sample Location Y** parameter.

Making Birefringence Measurements

The Exicor main window allows the user to perform two types of measurements:

These Types of Measurements	Have these Uses
	Making an individual reading at a particular location.
Single Point Measurements	Stepping around on the sample and measuring different points in order to set up an area scan.
Area Measurements	Gathering large amounts of data with minimal user attention.
	Storing measurements to a file.

Point Measurements

Figure 4.7 shows the Interactive Scan panel, located on the left-hand side of the Exicor main window:
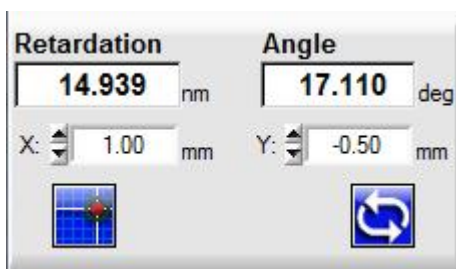

Figure 4.7 Interactive Scan Panel

The Interactive Scan panel is used for single-point measurements only. If it is necessary to scan an entire region, use the Automatic Scan panel, as described on page 43.

To take a single-point measurement, use one of the following techniques:

1. Double-click on the plot area at the desired grid point to move to that location and take a measurement.

2. Enter the X and Y coordinates of the desired location to measure into the **X** and

   Y fields in the Interactive Scan panel, and then click .

3. Use the cursor keys on the keyboard to move the stage to the desired position

   then click .

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°. Use the following Figure 4.8 as a reference for fast axis angle measurements.
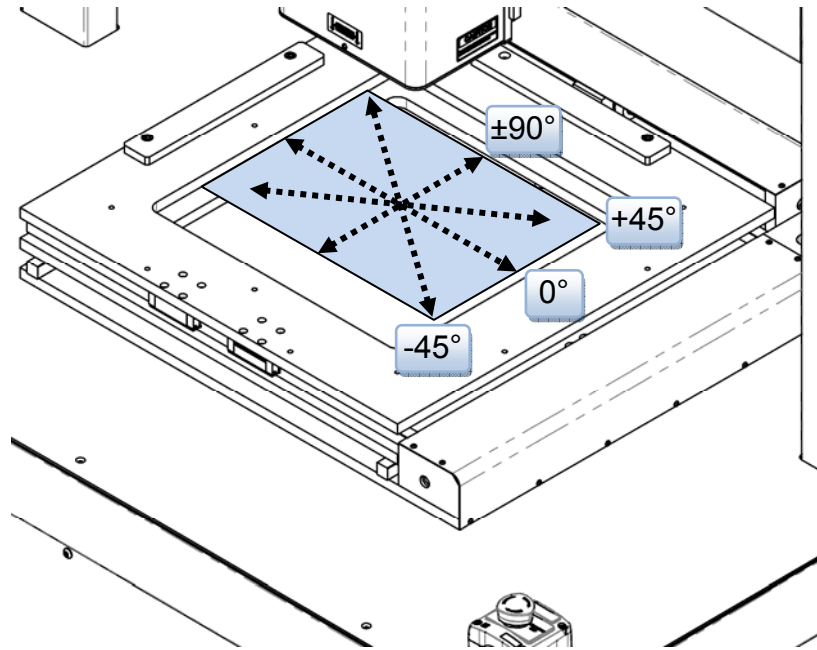

Figure 4.8 X-Y Motion & Fast Axis Angle

If the Retardation field reads "BLOCKED", this means there is not enough light getting to the detector. See Chapter 6 for more information on dealing with "BLOCKED" measurement results.

Using Cursor Keys to Move the Stage Position

Table 4.3 shows how to use the arrow cursor keys to move the X-Y stage. The current stage position is displayed in the **X** and **Y** fields in the Interactive Scan panel.
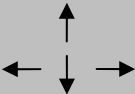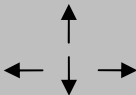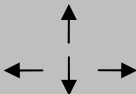
Pushing These Keys	Has this Effect		
↑ ← ↓ →	moves 1 grid space	⟶	**1X**
Ctrl + ↑ ← ↓ →	moves 10 grid spaces	⟶	**10X**
Shift + ↑ ← ↓ →	moves 1/10 grid space	▸	**X/10**

Table 4.3 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 [image] in the Interactive Scan panel. Alternatively, use the [image] button to make repeated measurements at the current stage position. This function is very useful when setting up a sample to be measured.

Automatic Scans

Automatic scans are used to make a measurement of a region or point of a sample material that is then saved to a file. The user must define the scan region and other scan settings to completely set up a scan.

Defining a Scan Region

The available scan regions are:

Circular: circle defined by 3 points on the circumference
Center/Radius: circle defined by a center and a radius
Rectangular: rectangle defined by the upper left corner and the lower right corner
Stationary: repeated measurement of a single point in the scan area
Zones (Optional): The X-Y scan area is divided into 4 symmetric zones, allowing the user to select which zones to scan and which areas of the zones to scan. This option is intended for use with the zones sample holder only.

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

 A rectangular scan is defined by an upper left coordinate, a lower right coordinate, and a grid spacing (same for x and y). Follow these steps to define a rectangular scan:

1. Select **Rectangular** from the drop-down menu under Scan Region. The scan control now looks like Figure 4.9 shown below.
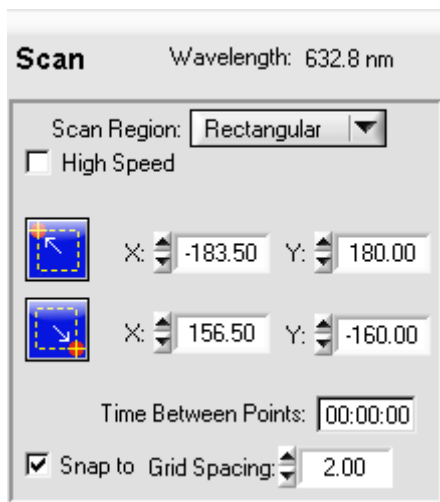

Figure 4.9 Automatic Scan Panel for Rectangular Scans

2. Move the stage to the desired upper left location and click

3. Move the stage to the desired lower right location and click
4. Enter the grid spacing to be used for the scan.
5. Select **High Speed** if desired to perform the scan with Scan In Motion.

Alternatively the user can enter the coordinates for the upper left and lower right corners.

Defining a Circular Scan

A circular scan is defined by 3 points on the circumference of the desired circular area and a grid spacing between points within the circle. Follow these steps to define a circular scan:

1. Select **Circular** from the drop-down menu under **Scan Region**. The scan control now looks like Figure 4.10 below.
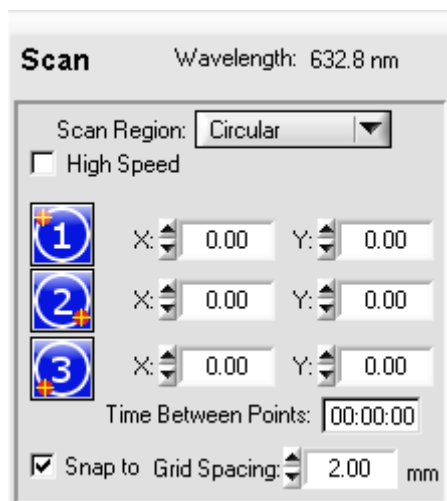
Figure 4.10 Automatic Scan Panel for Circular Scans

2. Use the arrow keys to move the laser beam to the edge of the sample. Click
   .

3. Use the arrow keys to move the laser beam to another point on the edge of
   the sample. Click .

4. Use the arrow keys to move the laser beam to another point on the edge of
   the sample. Click .

5. Enter the grid spacing to be used for the scan.

6. Select **High Speed** if desired to perform the scan with Scan In Motion.

Alternatively the user can enter the coordinates for the 3 points.

Defining a Center/Radius Scan

A center-radius scan is defined by the center and radius of the desired circular
region. Follow these steps to define a circular scan:

1. Select **Center/Radius** from the drop-down menu under **Scan Region**. The
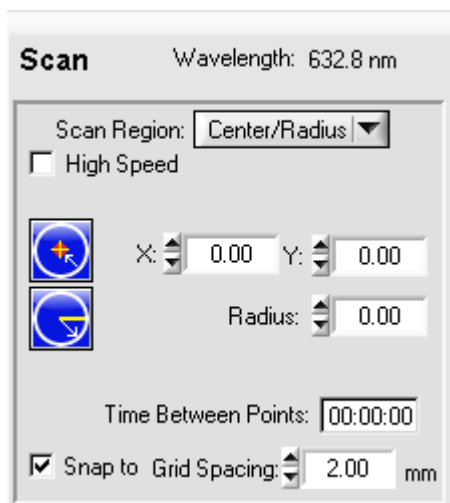   scan control now looks like Figure 4.11 below.

Figure 4.11 Automatic Scan Panel for Center/Radius Scans

2. Define the scan boundary using one of these methods:

   - Click and drag to define a circle. The point that is clicked will be the center of the circle. Hold the mouse button down and drag the mouse to define the radius.
   - Enter the X and Y coordinates of the center of the circle then enter the radius of the circle.

   - Move the laser beam to the center of the circular area and click .

     Move the laser beam to the edge of the circular area and click .

3. Enter the grid spacing to be used for the scan.
4. Select **High Speed** if desired to perform the scan with Scan In Motion.

Defining a Stationary Scan

The stationary scan type is used to repeatedly measure the same X,Y point on a sample. A stationary scan is defined by the point to be measured and the number of times to repeat the measurement.

Follow these steps to define a stationary scan:

1. Select **Stationary** from the drop-down menu under **Scan Region**. The scan control now looks like Figure 4.12 below.
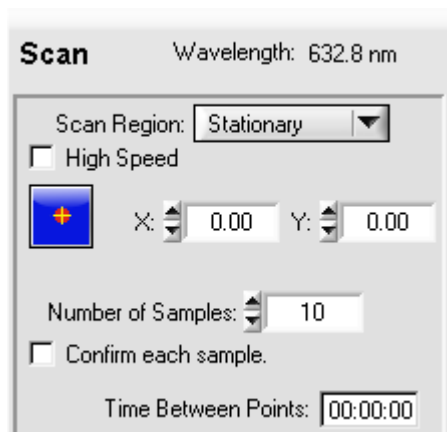
Figure 4.12 Automatic Scan Panel for Stationary Scans

2. Define the location and number of samples using 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 in the **Number of Samples** field.

   - Move the sample to the desired location and click [+]. Then enter the number of times to measure the point in the **Number of Samples** field.

3. Select **High Speed** for precisely timed data collection. Leave the box unchecked for regular speed. Refer to Table 4.4 below for a comparison between high speed and regular speed modes.

SETTING/ BEHAVIOR	MODE	
	Regular Speed	High Speed
LIA Sensitivity	As defined in **Configuration** →**System Parameters** → **HLIAs**	
LIA Time Constant	As defined in **Configuration** →**System Parameters** → **Settings**	**"4 ms" Fixed**
Number of Averages	As defined in **Configuration** →**System Parameters** → **Settings**	**Fixed to 1**
Measurement Repeatability	**Higher** - Depends on LIA sensitivity and number of averages	**Lower** – LIA sensitivity and number of averages is set to speed-optimized settings
Measurement Speed	**Slower** – Measures as fast as it can given the number of averages and the need to update the data plot	**Faster** – Fixed at precisely 100 points/second for stationary scans
Plot Update	**Real Time**	**At End of Scan**

Table 4.4 Overview of High Speed Mode vs. Regular Speed Mode

Defining a Zone Scan

The "zones" scan type divides the scan area into 4 areas so that the same scan can be performed in each area and the data for each area saved to a separate file. This feature is only compatible with a zones sample holder. A zones scan is defined by the zone numbers to scan and the area to scan within each zone. Zone scans are rectangular shapes only.

Follow these steps to define a zones scan:

1. Select **Zones** from the drop-down menu under **Scan Region**. The scan control now looks like Figure 4.13 below.
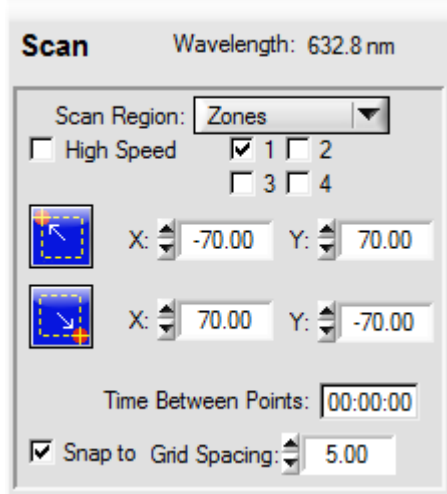
Figure 4.13 Automatic Scan Panels for Zones Scans

2. Define the zones to be scanned by putting a check in the box next to the desired zone numbers.
3. Define the area to scan within each zone by entering the upper left and lower right coordinates of the desired area in the fields provided.
4. Enter a new grid spacing if necessary.
5. Select **High Speed** if desired to perform the scan with Scan In Motion

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. Review the sample thickness and photoelastic constant settings and change as necessary in **Configuration →System Parameters → Settings**. Note that the birefringence and stress results will not be correct unless the sample thickness and photoelastic constant are correct.
2. Perform an air offset manually or set the system to perform this automatically before beginning the scan. See page 37 for more information.
3. Click **Start Scan**.
4. In the pop-up window, enter the sample ID to use as the file name and change the file location is necessary. If a Sample ID is not entered, the file will be called "DefaultID.DAT".
5. Click **OK** to start the scan.

The scanning process begins as soon as **OK** is pushed. The data will be taken in a serpentine fashion staring at the top of the scan area. During scanning, the user will notice periodic excursions of the X-Y-Motion Stage as the auto-offset feature operates (if enabled). The **Time Left** field shows approximately how much time is remaining until the end of the scan. After the scan is complete, the data is saved automatically.

If notes have been added after the completion of the scan, the Sample ID needs to be changed, or the legend settings have been changed, re-save the data by clicking **File → Save**. Enter the new Sample ID when prompted if the Sample ID needs to be changed. Then select the path and name of the file to which to save the data.

Viewing Scan Results

The plot area shows the measurement data for the currently open data file. Using a mouse, the user can select a grid point to display the measured data in the **Retardation, Birefringence, Stress,** and **Angle** fields. By selecting more than one grid point (by dragging the mouse), the user can either outline an area for a new scan, zoom in on the area, or view the statistics of the selected area.

When a stationary scan is open, the data plot changes from an X-Y plot to a line plot. The horizontal axis of the line plot is point number in order collected.

The grid spacing shown on the plot is the same grid spacing that was used for the scan. If no file is open, the grid spacing of the plot will be the same as the default grid spacing for the system.
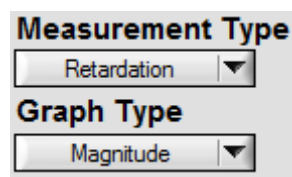
The Exicor software offers several controls to modify the display of the scan data:

- Measurement/Graph Type
- Legend
- Zoom Controls
- Scan Statistics
- Adding Notes

Measurement/Graph Type

Figure 4.14 below shows the **Measurement Type** and **Graph Type** controls, which are located in the upper right corner of the Exicor main window.

Figure 4.14 Measurement/Graph Type Controls

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

- **Retardation:** the magnitude of linear retardation – units are nanometers (nm).

- **Birefringence:** the magnitude of linear retardation normalized to the beam path length in the sample (sample thickness) – units are nanometers per centimeter (nm/cm).

- **Stress**: the estimated magnitude of mechanical stress – units are pounds per square inch (psi).

- **DC**: the strength of the detector signal – units are volts (V). This is useful for investigating any possible correlation between retardation magnitude and signal strength. Measurements can sometimes be affected if the beam is clipping an edge of the sample or the sample holder (this condition reduces the signal strength at the detector).

The **Graph Type** control selects the method used to display the data. The options are

Mag: 2D color plot of one of the measurements above.
Angle: 2D vector plot of only the fast axis angle.
Mag & Angle: 2D color plot of the magnitude of one of the measurement types above with the angle vector plot overlaid on top.
Mag 3D: 3D surface representation of the magnitude of the one of the measurement types above. The magnitude is represented both by color and height of the surface.
Line Chart: Line graph view of the data points in the order collected. All measurement types are shown together.

Legend

The legend shows the color key for the currently selected plot. There is a drop-down menu that allows the user to select the type of legend for the plot. The types of legends are:

Custom: Data points are shown as a specific color. The magnitude range is divided into 10 sections, each having a unique color. The legend minimum, maximum, and color for each section is customizable.
Gray Scale: Data points are shown as shades of gray. The selected range is shown on a continuous spectrum from black to white. Black represents low numerical results while white represents high numeric results. The legend minimum and maximum values are customizable.
Spectral: Data points are shown as shades of the visible color spectrum. The selected range is shown on a continuous spectrum from violet to red. Violet represents low numerical results while red represents high numeric results. The legend minimum and maximum values are customizable.
Figure 4.15 below shows the 3 different types of legends shown together in one figure.
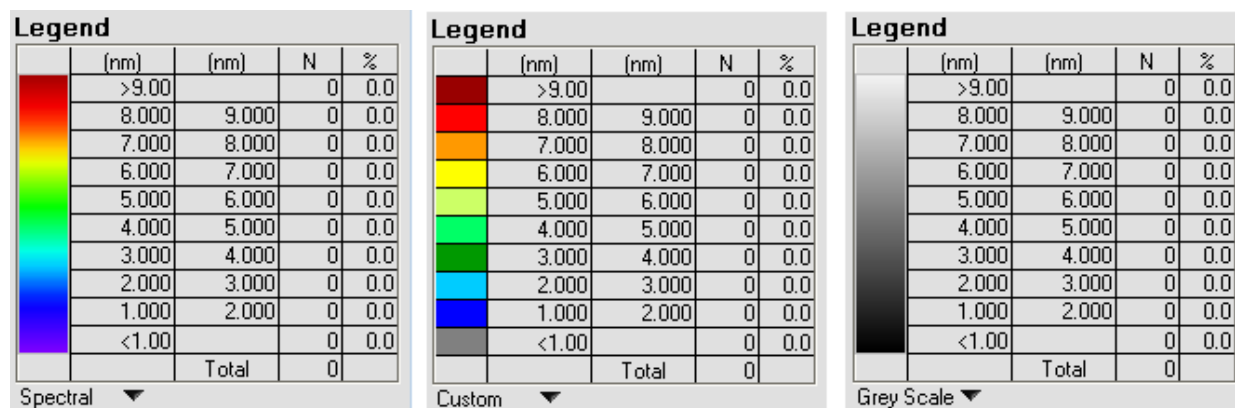
Legend						Legend						Legend				
	(nm)	(nm)	N	%			(nm)	(nm)	N	%			(nm)	(nm)	N	%
	>9.00		0	0.0			>9.00		0	0.0			>9.00		0	0.0
	8.000	9.000	0	0.0			8.000	9.000	0	0.0			8.000	9.000	0	0.0
	7.000	8.000	0	0.0			7.000	8.000	0	0.0			7.000	8.000	0	0.0
	6.000	7.000	0	0.0			6.000	7.000	0	0.0			6.000	7.000	0	0.0
	5.000	6.000	0	0.0			5.000	6.000	0	0.0			5.000	6.000	0	0.0
	4.000	5.000	0	0.0			4.000	5.000	0	0.0			4.000	5.000	0	0.0
	3.000	4.000	0	0.0			3.000	4.000	0	0.0			3.000	4.000	0	0.0
	2.000	3.000	0	0.0			2.000	3.000	0	0.0			2.000	3.000	0	0.0
	1.000	2.000	0	0.0			1.000	2.000	0	0.0			1.000	2.000	0	0.0
	<1.00		0	0.0			<1.00		0	0.0			<1.00		0	0.0
		Total	0					Total	0					Total	0	
Spectral ▼						Custom ▼						Grey Scale ▼				

Figure 4.15 Data Plot Legend (all types shown)

The 2 left-hand columns of the legend show the value ranges that are indicated by the color on the left. The **N** column shows the number of data points that are within each range. The **%** column shows the percent of the total points that are within each color range. To adjust the legend settings, double-click the legend on the main window. The legend control appears as in Figure 4.16 shown below.
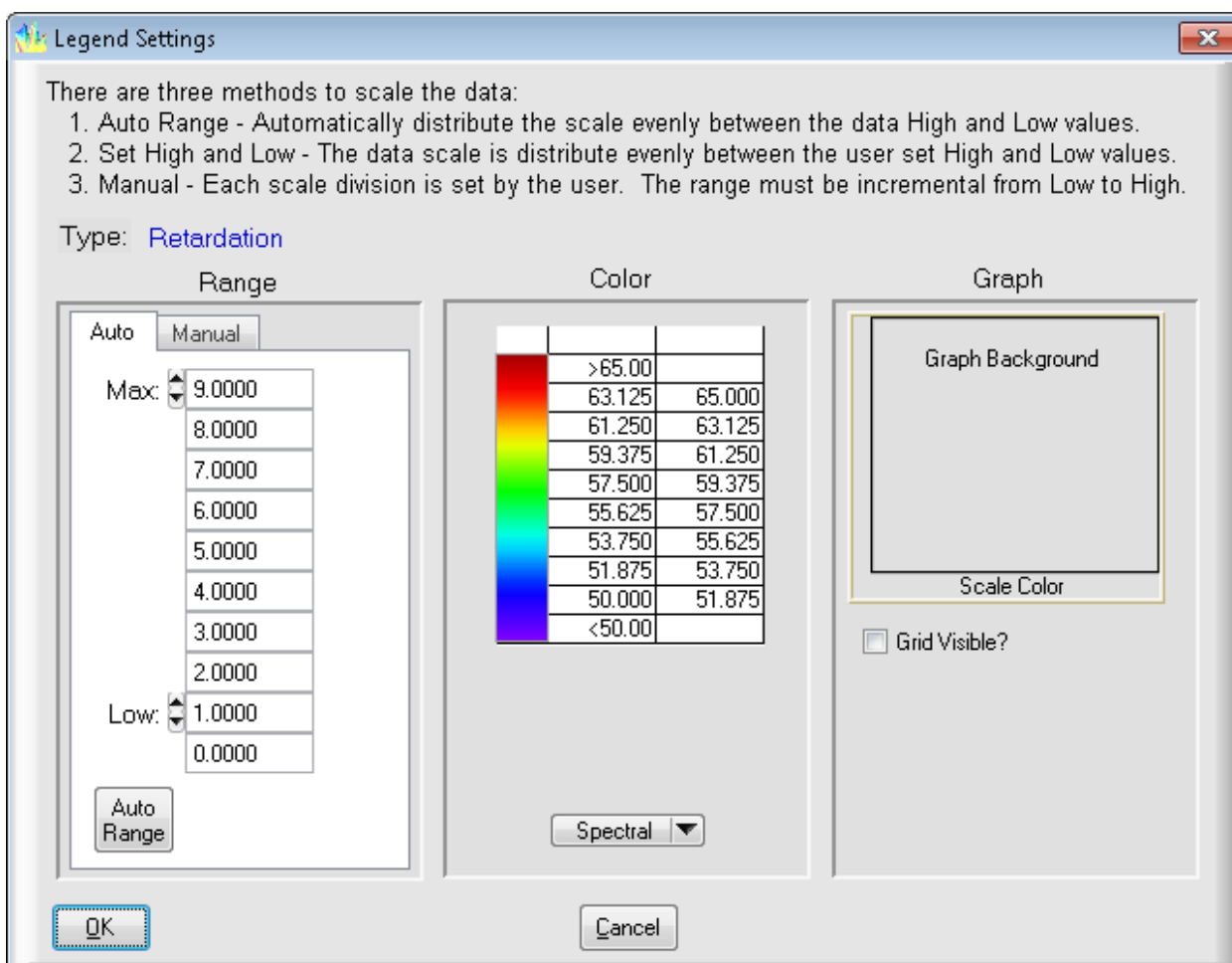
Figure 4.16 Legend Settings Window

The usage of the various controls is as follows:

Type: the current measurement type is shown. Settings can only be changed for the current measurement type. To change the color settings for another measurement type, exit the legend settings panel and choose another measurement type.

Range:
- **Auto** tab: 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 numerical results of the entire scan.
- **Manual** tab: these settings only apply to the Custom legend type. Enter the lower value for each color individually in the fields provided. The number ranges do not need to be equal.

Color: Shows a preview of the legend panel with the current settings applied. If the Custom legend type is selected, the colors can be edited by clicking on them in this area.

Graph: Clicking on the **Graph Background** area or the **Scale Color** area allows the user to change the color of these sections of the plot area on the main window.

The settings in the **Auto** tab will be saved with the data file when the data file is saved. The next time that data file is opened, the auto-range boundaries and increments will be reloaded. The settings in the **Manual** tab are saved to the system settings file. These will be the same regardless of which file is loaded. Once they are changed by the user, they will be saved to the system settings file and will be reloaded when the software is restarted.

Zoom Controls

The user can zoom in and out on the data by either the zoom control buttons or the mouse. An overview of the controls is given in Table 4.5 below.

Action	Result
	Zooms out to show the **entire stage area**
	Zooms the view in or out to make the **plot boundary the same as the data boundary**
Select area with mouse +	Zooms the view in to **show only the selected data** points
Roll mouse wheel away from monitor	**Zoom Out**
Roll mouse wheel toward monitor	**Zoom In**

Table 4.5 Overview of Zoom Controls

Scan Statistics

Clicking on ![icon] in the Exicor main window opens the statistics dialog box, shown the Figure 4.17 below.
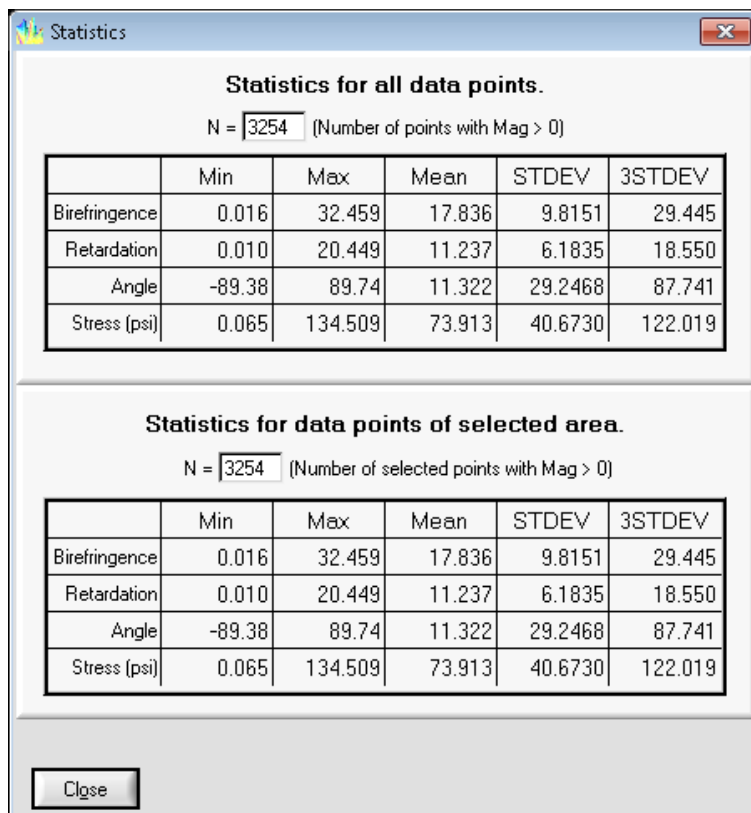
Figure 4.17 Statistics Dialog Box

The upper section of the window shows the statistics for the whole scan. If a region of the data has been selected with the mouse, the statistics for that region appear in the lower section.

Adding Notes

The user can add comments regarding the sample, scan, etc. that will be saved with the data file. To add notes during or after the scan, click ![note icon], type comments as desired, and then click **OK**. If comments are entered after the scan is complete, the user needs to save the file (**File→Save**) to save the comments to the data file.

Copying Files to the Clipboard

The Exicor software enables the user to copy and paste data graphs to other applications that are capable of accepting bitmap images. To copy a scan to the clipboard, select **File → Copy Graph.** A window pops up with controls for hiding or showing the statistics and legend information and for rotating the plot image. Select the appropriate options and click **OK**.

The copied image contains the following information:

- 2D 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 the data (see Figure 4.18 below).

Figure 4.18 Example of "Copy Graph"

Only the currently displayed data is copied. To select the whole data set, click [icon] before clicking **Copy Graph**.

Printing Files

To print a data file, follow these steps:

1. Open the data file.
2. Use the mouse to select the area to print. If it is necessary to zoom in on certain data points, use the [icon] button or mouse wheel.
3. Select the measurement type and graph type that is to be printed.
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 **OK**.

Managing Files

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

When to Re-save Files

Although the Exicor software automatically saves files during automatic scans, the files should again be saved in the following situations:

- Notes have been added to the file.

- The sample thickness value has been changed. 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. When it is changed, the birefringence values will be recalculated and the plot redrawn. Do not change the sample thickness unless the original thickness was incorrect.

- The legend settings have been changed and it is desired to save the changes for future reference

When all desired changes have been completed, save the file via **File→Save** to save the new information.

File Formats

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

.DAT

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. The data is arranged in columns with a heading for each column. The most commonly viewed columns are

- **X**: The x coordinate of the point
- **Y**: The y coordinate of the point
- **Mag**: The retardation magnitude of the point
- **Biref**: The birefringence magnitude of the point
- **Stress**: The stress magnitude of the point
- **Time**: The time the data point was taken

.DMT

This file format contains:

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

Creating a New File

When **File → New** is selected 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. .
- The graph is zoomed out to show the entire stage area.

Opening an Existing File

When **File → Open** is selected from the Exicor menu bar, the Open dialog box appears. Again, this is similar to other Windows File Open dialog boxes. When a file is open, changing the grid spacing will result in the file being unloaded.

Using Macros

Macros are useful in the following situations:

- to define an area or multiple areas 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.

- to easily scan irregular shapes (i.e., shapes that are not rectangular or circular)

High Speed mode is not available in Macro mode.

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 4.19.
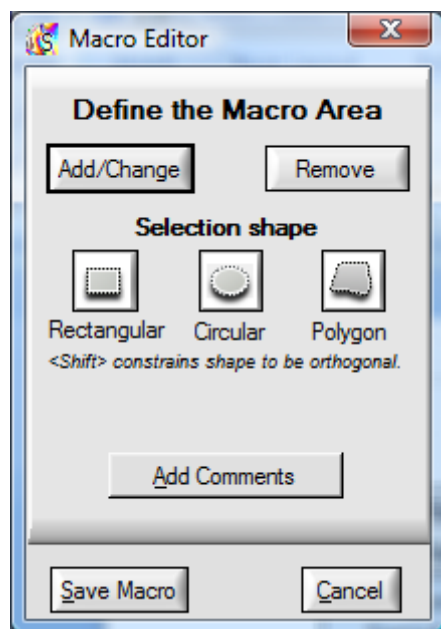
Figure 4.19 Edit Macro Dialog Box

To create a macro, follow these steps:

1. Go to the Automatic Scan panel and enter the desired grid spacing.
2. Select the type of shape to be created on the Macro Editor panel.
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.

6. 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 Figure 4.20 below.
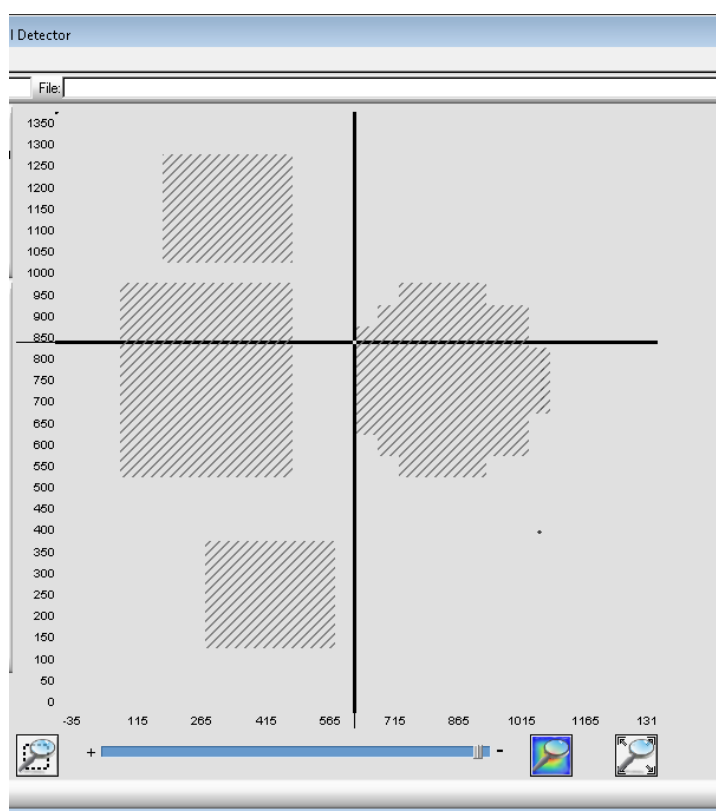
Figure 4.20 Shaded Areas Show Macro Regions to Be Scanned

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 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 a macro needs to be changed, 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.

5
Maintenance

The Exicor 300AT requires very little maintenance.

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 on the X-Y stage. 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).
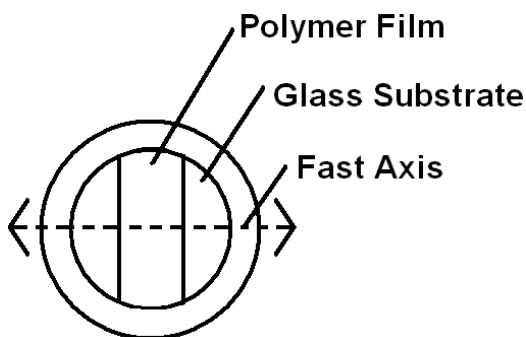
Figure 5.1 Fast Axis Orientation of Polymer Film Sample

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 (¼ wave system only).

The laser intensity will decrease over a period of time and the detector filters will degrade over time, resulting in decreased light to the detector. 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). ½ wave systems will show 1 DC level while ¼ wave systems will show 2 DC levels.
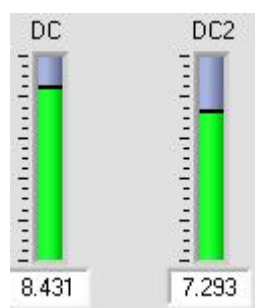
Figure 5.2 DC Level Indicator

Compare these values to the values before shipment of the system as provided on the ATP document. If either of these values falls below 1.5V (¼ wave system) or 0.3 V (½ wave system), 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 mW. If the laser power is still above 1 mW then the detector filters are the probable cause of low DC levels. For a ½ wave system, there are no detector filters so if the laser power is OK but the DC level is low, the laser may have become misaligned.

Fuse Types

The Exicor 300AT instrument has 2 user serviceable fuses. Both fuses are located on the outer panel of the master electrical enclosure, which is located at the rear of the scanning module. These fuses are installed on the main power line coming into the system. Under normal conditions, these fuses should not need to be replaced. If necessary, replace the fuses with the type shown below.

Main System Power Fuse (Qty 2)

Voltage	Fuse Rating	Hinds Part Number
100-240 VAC	5x20mm, 5A, 250V, SB	345-8000-034

Table 5.1 Main Power Fuse

Sample Stage Maintenance

It is necessary to lubricate the ball screws and the guide rail bearings of the X-Y stage periodically to ensure smooth operation and long life of the stage. See Figure 5.3 for lubrication locations.

CAUTION

Do not use/mix petroleum base grease with synthetic base grease at any time.

The grease type used is THK AFB-LF. This is lithium-based synthetic grease with consistency rating No. 2 (NLGI). Use only this grease when lubrication the X,Y stage.

1. Remove Ball Screw Covers

2. Lubricate Ball Screw Nuts with Conical Adapter

3. Lubricate Main Bearings with Inverse-Conical Adapter (8 Bearings Total)
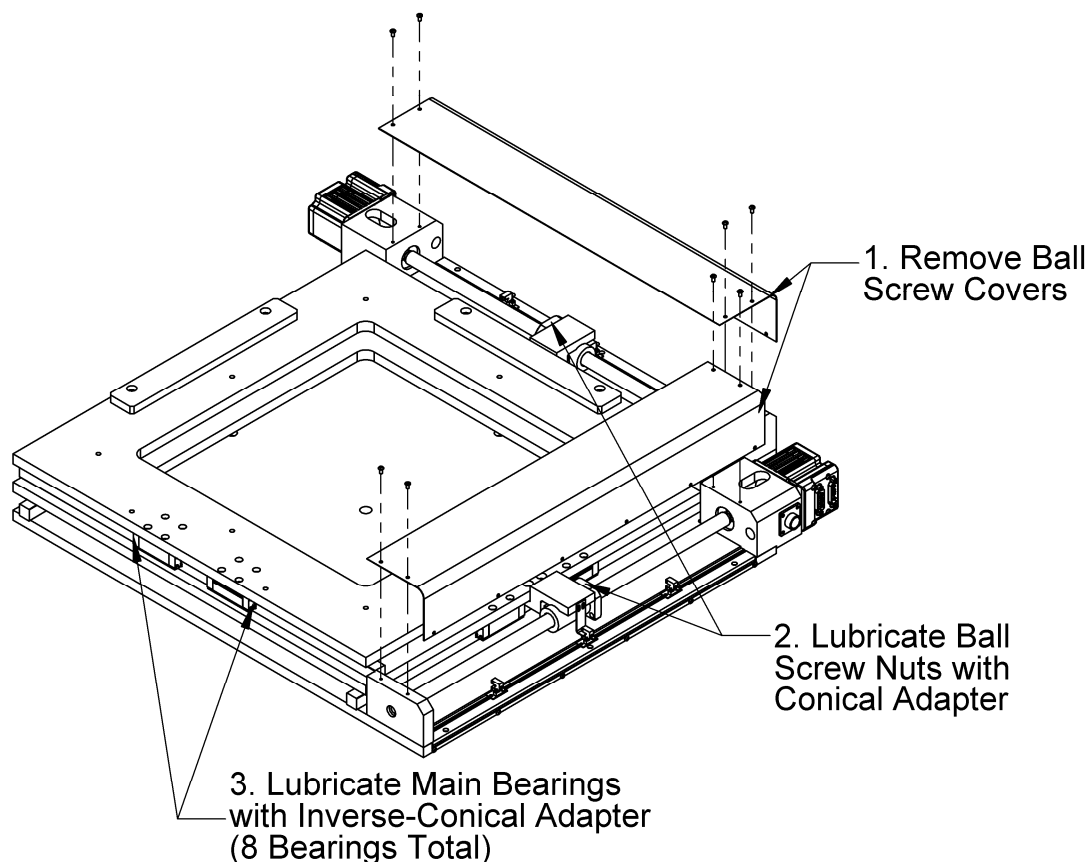
Figure 5.3   X-Y Stage Lubrication

Ball Screws

The X-Y stage has 2 ball screws that need lubrication – 1 per axis. Lubrication is performed by inserting grease into the nut of each ball screw. Lubricate the two ball screws 2 times per year following this procedure:

1. Power the system OFF.

2. Remove the ball screw covers as shown in the figure above.

3. Wipe both screws down with a clean cloth to clean away any contaminated grease.

4. Move the stage top by hand so that it is near the front-right corner of travel.

5. Attach the needle-point adapter to the grease gun. Hold the adapter tightly in the threaded hole in the ball screw nut. Insert 2 full pumps of the grease gun into the nut. Make sure that grease did not leak around the sides of the needle-point adapter. Repeat this for the other ball screw.

6. Move the table top by hand so that it is in the center of travel. Use the grease gun to insert 2 more full pumps into each ball screw nut. Grease should now be seen seeping out of the ends of the ball screw nut.

7. Move the stage top by hand to the back-left end of travel. Grease should now be well circulated through the bearings inside the ball screw nut as well as on the screw surface.

8. Install the ball screw covers after lubricating the guide rail bearings (if necessary).

Main Bearings

The X-Y stage has a total of 8 bearing blocks that need lubrication – 4 per axis. Lubrication is performed by inserting grease through the Lubricate the guide rail bearings on the X-Y stage once per year using the following procedure:

1. Move the stage top to the middle of travel.

2. Inspect each guide rail and clean any contamination with a clean, lint-free cloth.

3. Attach the rubber seal adapter to the grease gun.

4. Press the grease gun adapter firmly up to the grease fitting on one of the bearing blocks. Insert 2 pumps from the grease gun.

5. Repeat this step for the remaining bearing blocks.

6. Install the ball screw covers (if they had been removed).

Fan Filter

The Exicor 300AT has 1 cooling fan in the master electrical enclosure (MEE) to reduce the temperature of the electrical components. The air inlet on the master electrical enclosure has a filter to keep dust and other particles out of the module. The filter is located on the back side of the MEE, inside the scanning module. The filter should be cleaned or replaced 2 times per year.

To clean the filter, use the following procedure:

1. Power the system OFF.
2. Remove the 4 screws that secure the MEE to the rear of the scanning module.
3. Grab the handles of the MEE and pull it gently out so that the rear panel is accessible.
4. Use a small screwdriver to pry the filter retainer from the base of the filter
5. Pull out the filter and hold it under running water to remove any dust particles that have accumulated on the filter. Wait for the filter to dry fully.
6. 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:

Part Number: 330-1000-017-R
Description: Filter Replacement, 92mm Sq Fan

Opening Covers

Check periodically and whenever the system is moved or maintained, that the covers on the scanning module are secured and tight fitting. 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 trained and 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 the laser light used.

- Not allow eye exposure directly from laser light or any reflection of laser light from a mirror like surface.

- Understand the operation of the laser high-voltage connection and the associated shock hazard.

Cleaning the Optics

Under normal operation, the optics do not require cleaning. Optics that occasionally get contaminated are the PEM (½ wave system) or beam splitter mirror (¼ wave system). Contamination is only a problem if it is either scattering or absorbing the laser light. Never clean or touch the optics when the system power is ON.

If the contamination is dry particulate, remove it by blowing clean, dry air across the optic using either a can of compressed air or a hand-operated blower.

If a liquid such as index matching fluid drops into the detector aperture, the liquid could coat the second PEM or beam splitter mirror. If this occurs, gently clean the beam splitter mirror with cotton swabs moistened with isopropyl alcohol. Do not attempt to clean the PEM. The orientation of the PEM has been precisely set at the factory before shipment and cleaning it could change the orientation. Do not use solvents such as acetone, MEK, etc on the beam splitter mirror. 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 5.4 below.

Direction of
wiping motion
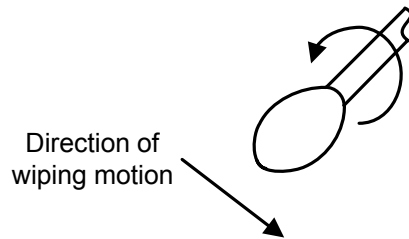
Figure 5.4   Direction of cotton swab wiping motion

Cleaning the Exterior

The exterior of the Exicor 300AT can be cleaned with an ammonia-based cleaner (such as glass cleaner).

> ### CAUTION
>
> To avoid electrical shock and equipment damage, do not allow any liquids to get inside the Exicor 300AT.
>
> Do not clean the system with the power ON or while the system is plugged into the AC outlet.

6
Troubleshooting & Help

Diagnosing Common Errors

Table 6.1 lists some errors you may encounter, and suggestions on how to interpret or fix the error.

	Symptom	Common Causes	Solutions
1	Main power switch will not turn system on (laser and motor lights are not evident)	EMO switch activated (button pushed in) AC power cord not plugged in	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)	Communication cable to data buffer disconnected	Check the "Buffer" connection between the PC and the scanning module Restart software
3	Error message: "problem communicating with the Lock in Amplifiers"		
4	Motion controllers fail initialization (with system powered ON)	Communication cable to motion controllers disconnected One or both motion axes stuck at a hard stop	Check for proper communication cable connections between the PC and scanning module Power the scanning module down, move the stage to near the center position, power the system back on Use the cursor to move the other direction. Actuators cannot travel beyond preset factory limits Restart software
5	Sample stage will not move		

	Symptom	Common Causes	Solutions
6	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 laser fuse. Replace as necessary. Check the light path for anything that may be blocking the light from reaching the detector.
7	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
8	Birefringence = -0.1 in data file		
9	Shows 'Blocked' in Retardation box		
10	Measurement point on birefringence plot is a red X or is not plotted		
11	Birefringence magnitude is large with no sample present	Offset correction not performed regularly Beam obstructed during offset measurement	Perform air offset measurement, making sure the beam path is not obstructed.
12	Birefringence magnitude is larger than expected with sample present		
13	Software freezes during 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 6.1 Diagnosing Common Errors

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 6.2 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)

A
Technical Specifications

General Description

The Exicor 300AT is an integrated system to measure low-level birefringence in optically transparent samples up to 300mm x 300mm. An extensive system-specific operating software program provides the following:

- Graphical user interface

- Automated motion control of sample platform

- Manual control (via software) of the sample platform

- Graphing of sample data on screen and print

- Reading sample data from file to graph

- File management

Power Requirements

The Exicor 300AT system is designed to operate on the following (Including the computer and monitor):
100-240 VAC, 50/60 Hz, 3 A MAX

General Specifications

Software:	Exicor™ ATS 6.2 (025-0000-052)
Computer System:	PC, Windows™ operating system, LCD monitor
Scanning Module Dimensions:	127 cm (w) x 113 cm (d) x 175 cm (h)
Scanning Module Weight:	~ 210 kg
Safety Feature:	Emergency OFF switches
Modulation System:	Hinds Instruments PEMLabs Technology[SM] Ultra Low Birefringence Photoelastic Modulator
Safety Feature:	Emergency OFF switches
Measurement Units:	Retardation: nm, Birefringence: nm/cm, Stress: psi
Wavelength:	633 nm
Measurement Spot Size:	1 mm nominal[1]
Maximum Scan Region:	300 mm x 300 mm
Maximum Sample Weight (including holder)	50 kg
Maximum Sample Height	150 mm

[1] *Other spot sizes optional*

Performance Specifications

Retardation Range:	¼ Wave System	½ Wave System
	0 – 120 nm	0 – 316 nm
Retardation Repeatability[1]:	Regular Speed: ±0.01 nm (Re ≤ 1 nm), otherwise ± 1%	
	High Speed: ±0.03 nm (Re ≤ 3 nm), otherwise ± 1%	
Background Noise level[2] (without sample):	Regular Speed: 0.01 nm	
	High Speed: 0.03 nm	
Fast Axis Repeatability [1]:	±0.5° at Re > 1 nm	
Measurement Time:	Regular Speed: ~ 1.5 seconds per data point (depends on step size)	
	High Speed: 100 points/second MAX (not including data communication time)	

[1] Repeatability Conditions:

- Standard system. Options such as different spot sizes will change the repeatability specifications

- Repeatability = the 3σ value from 100 sequential measurements is less than the specified value

- System tests performed in a laboratory environment (temperature 18-24°C, stable to within 1°C/hour)

- Sample in a fixed position

- Machine stabilized for 1 hour with auto-offset time interval of 5 minutes

- Testing material: Polished, parallel-face optical element

[2] Noise Floor Conditions:

- Standard system. Options such as different spot sizes will change the noise floor specifications

- Definition: the average of 100 sequential measurements with no sample in the light beam

- System tests performed in a laboratory environment (temperature change <1ºC 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

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

- 3D surface plot

- 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

B
Exicor ® 300AT Limited Warranty

Hinds Instruments, Inc. warrants the Exicor ® 300AT 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 normal maintenance, 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.

THIS DOCUMENT REFLECTS THE ENTIRE AND EXCLUSIVE UNDERSTANDING OF THE PARTIES, EXCEPT AS OTHERWISE PROVIDED HEREIN. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, PARTICULARLY THE WARRANTIES OF MERCHANTABILITY AND/OR FITNESS FOR A PARTICULAR PURPOSE, ARE EXCLUDED.

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

Refer to Chapter 6 (Troubleshooting & Help) for contacting technical support.

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