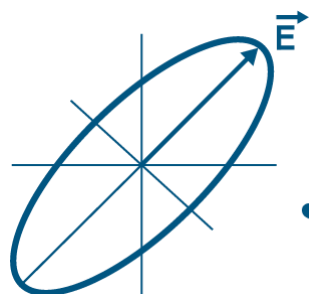
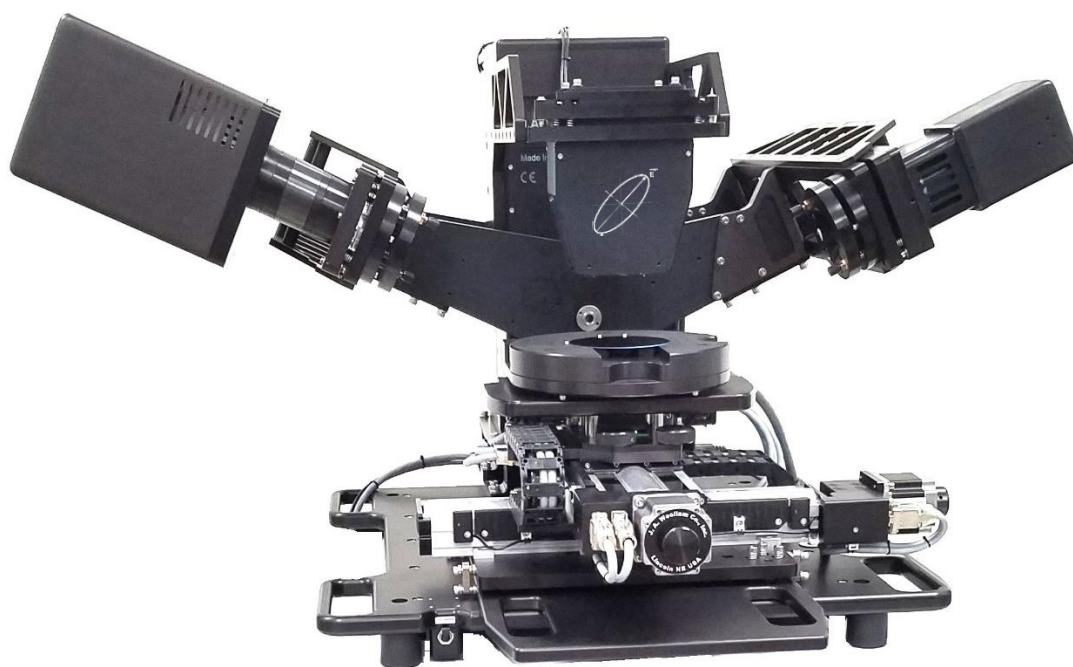


M-2000® Spectroscopic Ellipsometer

Hardware Manual
Auto-Angle ESM-300 Base
CompleteEASE® Software



J.A. Woollam

Ellipsometry Solutions

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Thank you for purchasing a J.A. Woollam Co. Spectroscopic Ellipsometer. We hope the information contained in this manual will help you develop a better understanding and appreciation for the ellipsometer and any accessories purchased.

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Contents

1	Safety Instructions	11
1.1	Message Boxes.....	11
1.2	General Safety Instructions.....	11
1.3	Environmental Operating Range.....	12
2	Hardware Description	13
2.1	System Configurations	13
2.2	System Components	13
	Source Units	13
	Receiver Units.....	18
	Fiber Optic Cables.....	19
	Detector/Lamp Power Control Module.....	20
	Electronics Control (EC) Module	20
	Computer	21
	Surge Suppressor.....	21
	USB Camera (Optional).....	21
	Auto-Angle ESM-300 Base Unit	21
	Power Control Module (Optional).....	22
3	Installation	23
3.1	System Assembly	23
	Preliminary	23
	Base Assembly.....	25
	AC Wiring.....	29
	Cabling.....	31
	Computer	33
	Rack Mount Table Option.....	33
	System Enclosure Option	36
	Lamp Installation (if applicable)	41
3.2	Electronics Control (EC) Module Setup.....	42
	Configuring the EC Module	42
3.3	Operator Computer Setup	43
	Software Installation	44
	Windows Network Setup	44
	USB Camera.....	46
	High Performance Mode	49
4	Preparing the System for Use	51
4.1	Power up Procedure	51
4.2	Conventions Used in this Manual	52
4.3	File Organization & Manipulation.....	53
4.4	Operation	53
	System Alignment	54

Sample Alignment	57
System Check (Calibration).....	57
4.5 System Alignment (with Manual Tip/Tilt).....	58
Source Unit Alignment	59
Receiver Unit Alignment.....	61
Verify Signal.....	63
4.6 System Alignment (with Automated Tip/Tilt).....	66
Source Unit Alignment	68
Receiver Unit Alignment.....	69
Verify Signal.....	71
Sample Stage Alignment	74
Lookdown Detector Alignment	77
4.7 Sample Alignment (with Manual Tip/Tilt).....	82
4.8 Sample Alignment (with Automated Tip/Tilt)	84
4.9 System Check (Calibration)	85
Evaluating Calibration Results	87
4.10 Instrument Shutdown	88
5 Data Acquisition.....	89
5.1 Acquiring Ellipsometric Data.....	89
5.2 Recipes	92
Prompt for Recipe Components	93
Creating New Recipes.....	94
Creating New Acquisition Parameters	95
Creating New Analysis Models	95
Using a Recipe	95
5.3 Data Types.....	97
Standard	97
Mueller Matrix.....	98
Reflection Intensity	99
5.4 Routine Test Measurements.....	101
Initial Setup	101
Viewing Results	102
6 Focusing Optics.....	103
6.1 General Overview	103
6.2 Installation	104
Standard Receiver Unit.....	105
Alignment Camera Receiver Unit	108
6.3 Lens Correction	110
6.4 Sample Alignment & System Check with Focusing Optics.....	111
6.5 Data Acquisition with Focusing Optics	113
6.6 Removal	114
7 Automated Translation (Optional)	115

7.1	General Operation	115
7.2	Scan Patterns	116
	Substrate Dimensions.....	117
	Point List and Point Commands	117
	Grid and Line Fill	119
	Test Scan	120
	Alignment Position	121
	Save	121
7.3	Rotator Option	122
	Wobble Correction	123
8	Sample Camera	125
	Illumination Control	125
8.1	Marking the Measurement Beam Position.....	126
8.2	Field of View Calibration	134
9	In Situ	137
10	Scheduled Maintenance	139
10.1	D2 & QTH Lamps (M-2000D, DI, U, & UI) in XLS-200.....	139
	Lamp Installation/Replacement	139
	Lamp Alignment	141
10.2	Xe Lamp (M-2000X, XI, X-210, & XI-210) in FLS-860.....	141
	Lamp Installation/Replacement	142
	Lamp Alignment	145
	Arc Lamp Disposal	147
	Mirror Replacement	147
10.3	QTH Lamp (M-2000V & VI) in FQTH-100	148
	Lamp Installation/Replacement	148
	Lamp Alignment	150
10.4	Optical Fiber	151
10.5	Cleaning.....	151
11	Performance Checks	153
11.1	Calibration Wafer & Straight-Through Measurement.....	153
11.2	System Check	155
11.3	Verify Sample Alignment	155
11.4	Verify Signal/Lamp Intensity	156
11.5	Verify System Alignment.....	156
11.6	Angle of Incidence Offset Correction.....	157
11.7	System Calibration	157
	Overview	158
	System Calibration	158
	Wavelength Calibration.....	163
12	Troubleshooting.....	165

12.1 General Procedures	165
Debug File	165
12.2 Common Screen Error Messages	166
Phase Sensor Error Message	166
Polarizer Homing Error Message	167
Spectrometer Is Not Scanning	167
Communication Problems	167
12.3 General Problems	168
12.4 Software Problems and Error Messages	169
12.5 Calibration Problems	169
12.6 Signal Screen Problems	169
12.7 Lamp and Light Problems	170
12.8 USB Camera	171
13 Specifications	173
13.1 Components	173
Electronics Control (EC) Module	173
Detector / Lamp Power Supply Modules	174
Power Control Module	176
Surge Suppressor	178
Computer	178
Monitor	178
13.2 Environmental Operating Range	178

1 Safety Instructions

1.1 Message Boxes

Three message boxes are used in this manual. They are explained below:

Warning: This box is used to warn the user of a potential hazard to the user or persons in the area of the ellipsometer.

Caution: This box is used to alert the user that an incorrect operation or procedure could cause damage to the equipment.

Note: This box contains tips, hints, and useful information relating to the procedure in which it is located.

1.2 General Safety Instructions

Warning: For safe operation of this equipment, do not use it in any way other than what is described in this user's manual or as recommended by the manufacturer.

- Keep hands/fingers/body parts away from the instrument while making motor position changes. Pinch points may be applicable (see below).

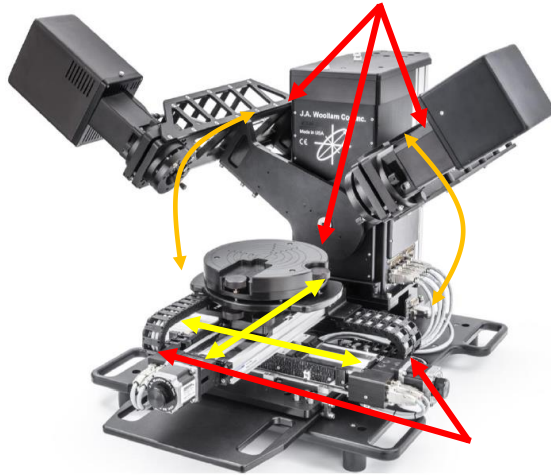


Figure 1-1. Potential pinch points.

- Ensure all system controls and power cables are tied/tucked away/hidden/kept away/arranged such that persons walking around the instrument area will not snag or trip on any of the cables.
- Replace bad fuses only with proper type and rated fuse.
- Never look into a tip of an optical fiber.
- Never look directly at an operating lamp, severe eye injury may result. Wear UV protective lenses, such as a welder's helmet, when working around operating lamps.
- Permanent eye damage can result from looking directly into the beam. It is best to view the beam using a piece of paper or business card.
- Before servicing this equipment, ensure that the power source is disconnected.
- Before servicing the lamp housing, be sure to disconnect all cables. Make certain the lamp is at room temperature (turn lamp off for at least 20 minutes).
- Compact arc lamps contain highly pressurized gas, and present an explosion hazard even when cold. Wear face protection, such as a full-face shield, gloves and a long sleeve shirt whenever handling lamps.

1.3 Environmental Operating Range

- Temperature: 10°C to 35°C
- Humidity: 20% to 80% (non-condensing)

2 Hardware Description

2.1 System Configurations

This manual covers the full line of M-2000 based spectroscopic ellipsometers mounted on the auto-angle ESM-300 base.

MODEL	SPECTRAL RANGE	LAMP(S)
M-2000D(I)	193-1000 (1690) nm	30W Deuterium and 20W QTH
M-2000X(I)	210 (245)-1000 (1690) nm	75W Xenon arc
M-2000U(I)	245-1000 (1690) nm	30W Deuterium and 20W QTH
M-2000V(I)	370-1000 (1690) nm	50W QTH

Table 2-1. M-2000 models, spectral range, and lamp(s).

2.2 System Components

The M-2000 spectroscopic ellipsometer system is based on advanced Diode Array Rotating Compensator Ellipsometer (DARCE™) technology from the J.A. Woollam Co. This technology provides consistently accurate ellipsometric data, independent of the sample characteristics.

Source Units

The following source units are used for M-2000 ellipsometers.

XLS-200 Source Unit

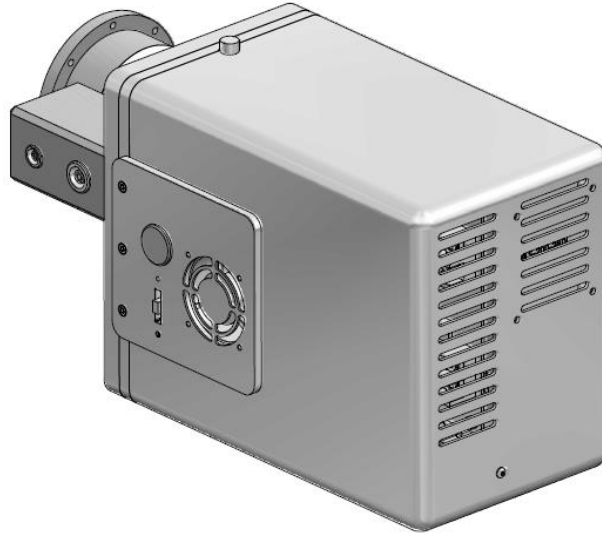


Figure 2-1. XLS-200 Source Unit.

M-2000D(I) and M-2000U(I) ellipsometers use the XLS-200 Source Unit. The XLS-200 Light Source houses the D2 (Deuterium) and QTH (Quartz Tungsten Halogen) lamps. Power for the lamps is supplied through highly regulated switching DC power supplies located in the M-2000 XLS light source. The Source Unit also contains the beam collimation optics, a fixed polarizer, and a compensator located in a continuously rotating stepper motor.

30 watt D2 Lamp



Figure 2-2. D2 lamp.

The D2 (Deuterium) lamp supplies light from the UV to the visible region of the spectrum. This lamp is mounted just behind the shutter aperture.

20 watt QTH lamp



Figure 2-3. QTH lamp.

The QTH (Quartz Tungsten Halogen) lamp supplies light from the visible to the NIR region of the spectrum. This lamp is mounted just behind the D2 lamp aperture.

Warning: The D2 and QTH lamps get extremely hot during operation. Always allow them to cool adequately before replacing them.

FLS-860 Source Unit



Figure 2-4. FLS-860 Source Unit.

M-2000X(I) ellipsometers use the FLS-860 Source Unit. The FLS-860 Light Source houses the 75W Xenon arc lamp and igniter circuitry. The Source Unit also contains the beam collimation optics, a fixed polarizer, and a compensator located in a continuously rotating stepper motor.

75 watt Xenon Arc Lamp



Figure 2-5. Typical arc lamp.

The Arc Lamp is a high pressure Xenon discharge point source lamp. It is filled with Xenon gas at above atmospheric pressure. The lamp is mounted in an inner enclosure within the source unit.

Warning: Compact arc lamps contain highly pressurized gas, and present an explosion hazard even when cold. Wear face protection, such as a welder's helmet, whenever handling lamps.

Warning: The Xe arc lamp gets extremely hot during operation. Always allow it to cool adequately before replacing the lamp.

Neutral Density Filter Wheel (Optional)

The Source Unit may include an optional neutral density (ND) filter wheel (auto or manual). The auto filter wheel is controlled by the software and can be set to auto select the intensity level by checking the "Auto" box. This is used to select the optimum intensity level for the sample under measurement.

The intensity can also be set by the user to a specified value by un-checking the "Auto" box and selecting the filter value from the drop down menu. This can be helpful during system alignment.

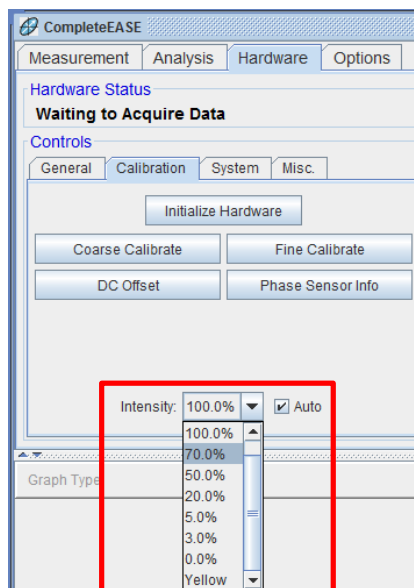


Figure 2-6. Auto Filter Wheel intensity selection option.

The manual filter wheel option has eight (8) detent positions:

POSITION	INTENSITY
0	100%
1	70%
2	50%
3	20%
4	10%
5	5%
6	3%
7	Yellow – Long Pass filter at 530nm

Table 2-2. Manual Filter Wheel positions.

Rotate the filter wheel to select the amount of light intensity needed for the sample under measurement.

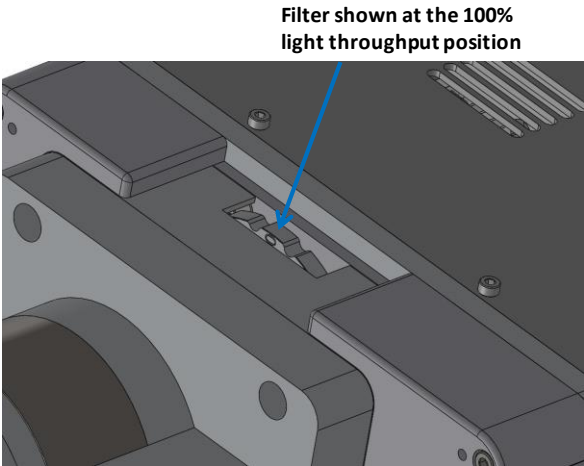


Figure 2-7. Source Unit Manual Filter Wheel.

FQTH-100 Source Unit

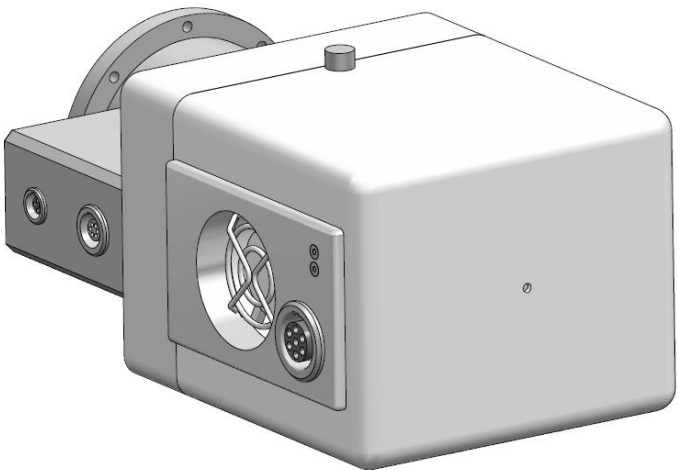


Figure 2-8. FQTH-100 Source Unit.

M-2000V(I) ellipsometers use the FQTH-100 Source Unit. The FQTH-100 Light Source houses a 50W QTH (Quartz Tungsten Halogen) lamp. The Source Unit also contains the beam collimation optics, a fixed polarizer, and a compensator located in a continuously rotating stepper motor.

50 watt QTH Lamp



Figure 2-9. Typical QTH lamp.

The QTH (Quartz Tungsten Halogen) lamp is mounted just behind the pinhole in the rear of the lamp housing.

Warning: The QTH lamp gets extremely hot during operation. Always allow it to cool adequately before replacing the lamp.

Receiver Units

The following receiver units are used for M-2000 ellipsometers. There is also an optional Internal Alignment Camera used for fast sample alignment.

MQD-Single Receiver Unit

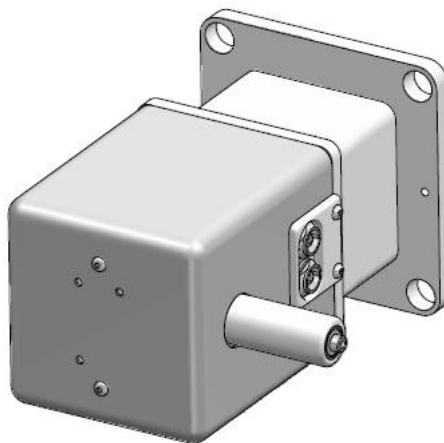


Figure 2-10. MQD Single Receiver Unit.

The MQD Single Receiver Unit is used on the M-2000D, U, X, and V systems. It consists of a stepper motor driven rotational stage which houses an analyzer. There is also a four-quadrant detector used for alignment of the system. This receiver contains one beam folding mirror and one fiber coupling lens (UV-VIS).

MQD-Dual Receiver Unit

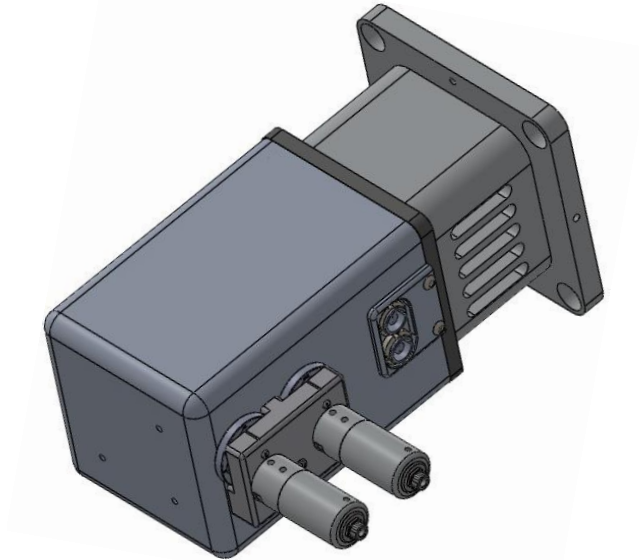


Figure 2-11. MQD Dual Receiver Unit.

The MQD Dual Receiver Unit is used on the M-2000DI, UI, XI, and VI systems. It consists of a stepper motor driven rotational stage which houses an analyzer. There is also a four-quadrant detector used for alignment of the system. This receiver contains two beam folding mirrors and two fiber coupling lenses (UV-VIS & VIS-NIR).

Fiber Optic Cables

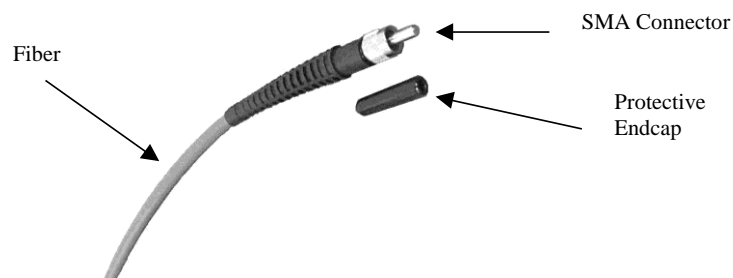


Figure 2-12. Optical fiber.

Fiber Optic Cables are used to couple the beam from the Receiver Unit to the Detector(s) located in the M-2000 Detector and Lamp Power Supply Module. The fibers have a 200 micron core diameter (standard), and are terminated on each end with an SMA connector for easy insertion and removal.

One DUV fiber is used in M-2000D, U, and X systems. M-2000V systems use one IR fiber since the spectrum is limited to 370nm. If the ellipsometer system has NIR extension, a second fiber is used for the NIR Detector. Fibers are normally 2 or 3 meters long, depending on application.

Note: When the fiber is first installed it needs to be oriented for maximum light throughput. This is covered in Chapter 10 Scheduled Maintenance.

Caution: Proper handling of the fiber is necessary to ensure long lifetime. When removing the protective rubber end cap, hold the end cap and pull the SMA connector nut. Do not pull directly on the fiber. Never allow the fiber tip to contact any other surface (fingertip, tabletop, etc.). Always cover the tips with protective rubber end caps when the fiber is not in use. The bend radius of the fiber should never be smaller than two inches. Never use a tool to tighten the fiber - it should only be finger-tight.

Detector/Lamp Power Control Module



Figure 2-13. M-2000 Detector and Lamp Power Supply Module.

The M-2000 Detector and Lamp Power Supply Module contains a UV-VIS Spectrometer covering a wavelength range of 193-1000 nm and an optional NIR Spectrometer that covers a wavelength range of 1000-1690 nm. It also contains highly regulated DC switching power supply for the Light Source. The switching power supply provides a very stable source of power for the system lamp(s).

Electronics Control (EC) Module



Figure 2-14. Electronics Control Module.

The Electronics Control Module contains a 486DX2 embedded computer. This computer is responsible for controlling the analog-to-digital (A/D) converter, the stepper motor drivers, and communicating with the host computer via a network card.

Computer

The computer operates the CompleteEASE data acquisition and analysis software. The main function of this computer is to communicate with the remote computer located within the electronics control module. It also analyzes all data acquired from the embedded computer and displays the results on the computer screen.

Surge Suppressor

The system is shipped with either 110 or 220V surge suppressor(s). These are provided to condition and filter the input AC power for the ellipsometer and to provide a central location for the system's AC power.

USB Camera (Optional)

The system may be shipped with an optional high resolution USB color camera. This camera comes with a multi-element lens attached or alignment optics. The CompleteEASE software allows the user to view and capture color images from the camera.

Auto-Angle ESM-300 Base Unit

The M-2000 spectroscopic ellipsometer system on the auto-angle base comes in three sizes depending on the mapping stage (if present).

- A small auto-angle base is used for systems with no mapping or a small manual mapping stage.
- A medium auto-angle base is used for systems with 100-200mm mapping stage.
- A large auto-angle base is used for systems with 300mm mapping.

The auto-angle base may also come with an optional rack mount table.

The base is for ex-situ use only. It brings together the Sample Stage, Source Unit, and Receiver Unit. It is used for calibrating, sample mapping, and taking data at various angles.

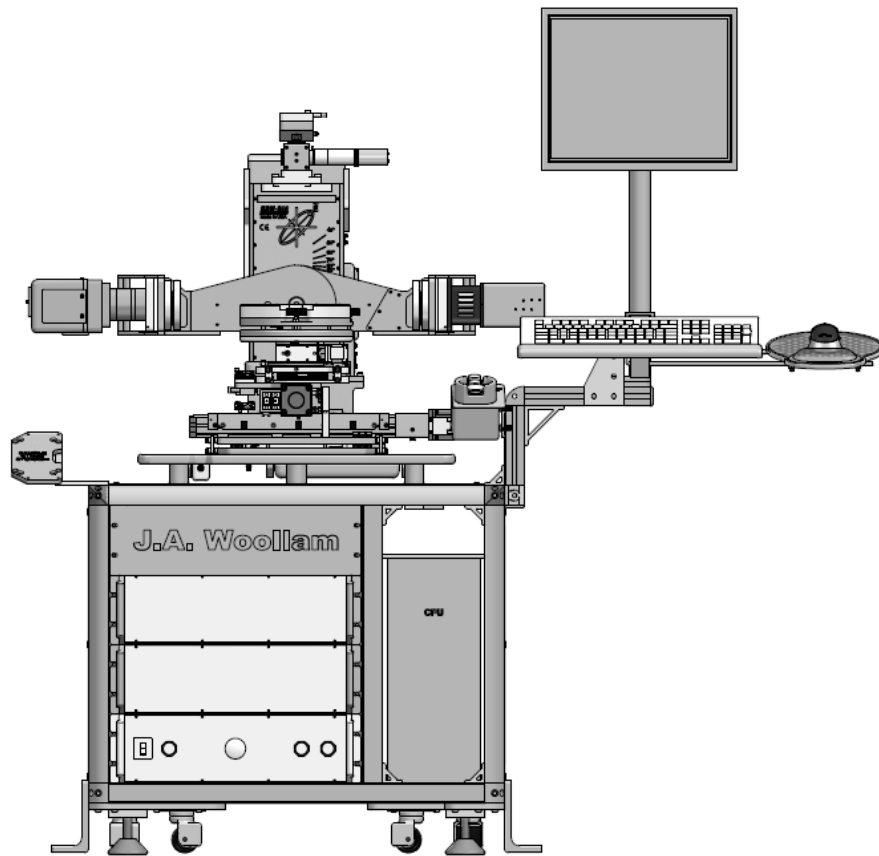


Figure 2-15. M-2000XI Medium Auto-Angle Base on table with 200mm X-Y mapping and Automated Tip/Tilt.

Power Control Module (Optional)



Figure 2-16. Power Control Module.

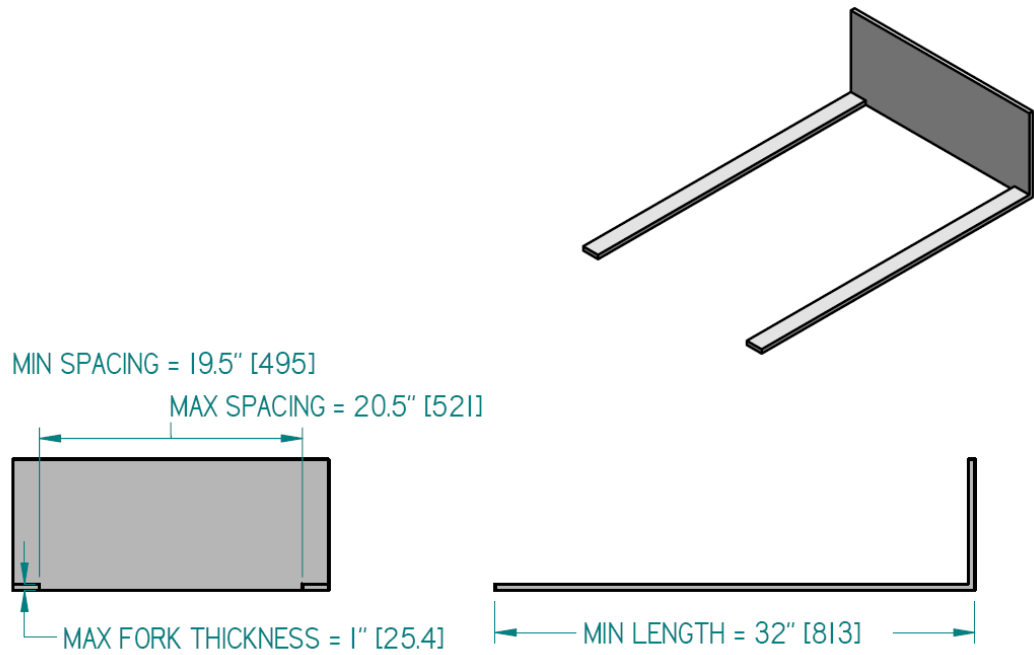
Systems supplied with the optional rack mount table include an Emergency Power Off Module. This module allows the user to Power Off the entire system by pressing one button in an emergency situation. It also acts as a centralized location for the system's power. AC power is connected to the back panel and it contains a 5Amp UL489 listed circuit breaker that has an AIC (Ampere Interrupting Capacity) rating of 5KA. The EPM-221 model contains a 10Amp circuit breaker along with additional 24VDC power and I/O interface.

3 Installation

3.1 System Assembly

Preliminary

- A good sturdy table is required, if the optional table is not included, that can support at least 150 lbs.
- The table should be away from high traffic areas and near an electrical outlet. The table should be placed such that there is at least 36 inches of clearance provided on all sides of the system.
- Open all boxes and/or crates.
- Carefully un-wrap all parts to ensure all components are present.
- Use a forklift to lift the ESM-300 base onto the supplied table. The fork must be rated to lift 300 lbs. and meet the requirements detailed in Figure 3-1.
- Position the forklift properly under the ESM-300 base and set the parking brake on the forklift.
- Lift the ESM-300 a few inches and pull the crate out from underneath the ESM-300. Do not put any part of your body under the ESM-300 or forklift.
- Lift the ESM-300 to about 40" above the floor and properly position the table under the ESM-300.
- Lower the ESM-300 onto the table. Be sure that all persons are clear before lowering the ESM-300 base onto the table.
- Roll the table and ESM-300 base away from the forklift.



FORK DETAIL FOR LIFTING ESM-300M BASE ONTO TABLE

Figure 3-1. Forklift details for lifting the ESM-300 Base.

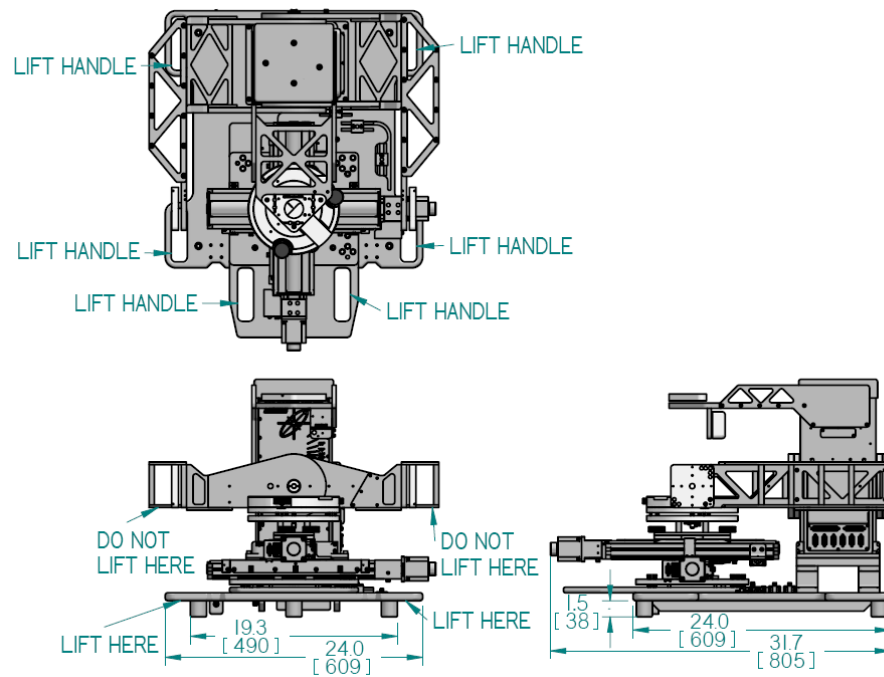


Figure 3-2. ESM-300 dimensions with respect to forklift placement.

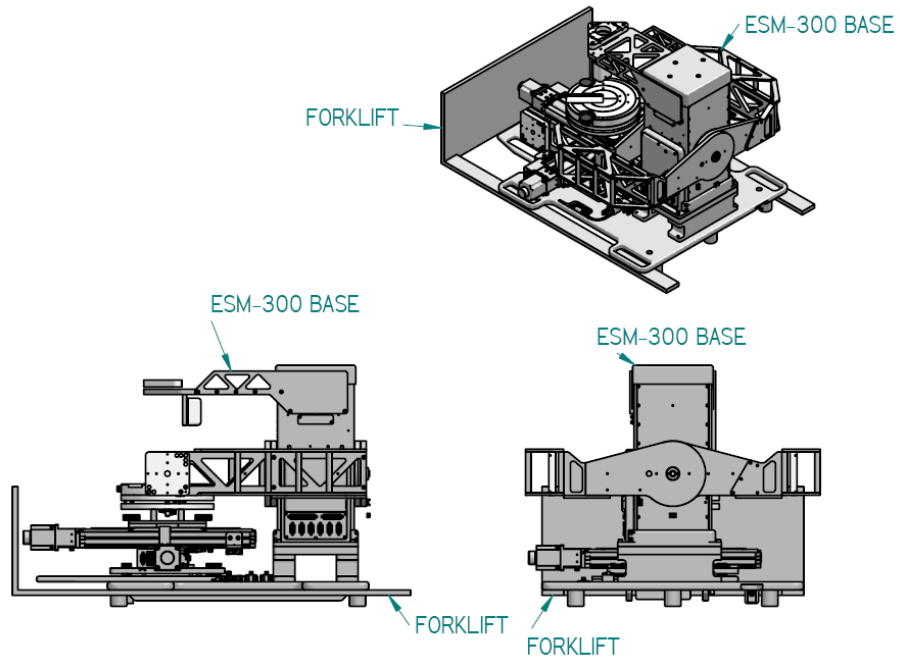


Figure 3-3. Forklift placement with respect to the ESM-300 base.

Base Assembly

1. Remove the base from the shipping container (DO NOT LIFT THE BASE USING THE ARMS) and set it the table.

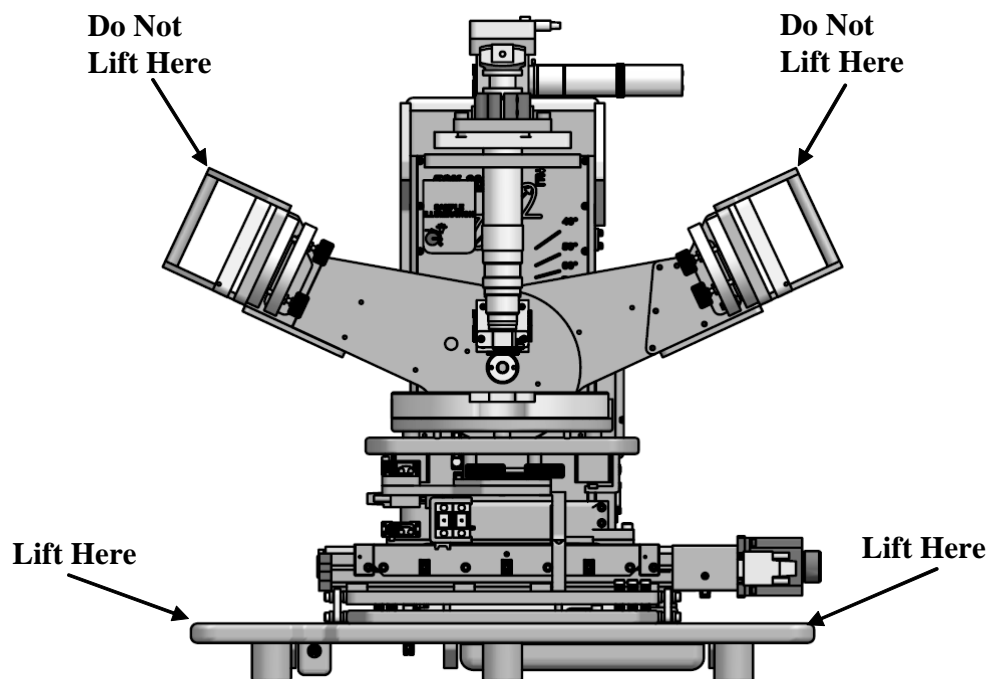


Figure 3-4. Lifting locations.

2. Remove the angle of incidence locking screw located on the left side of the base using a 4mm metric Allen wrench.

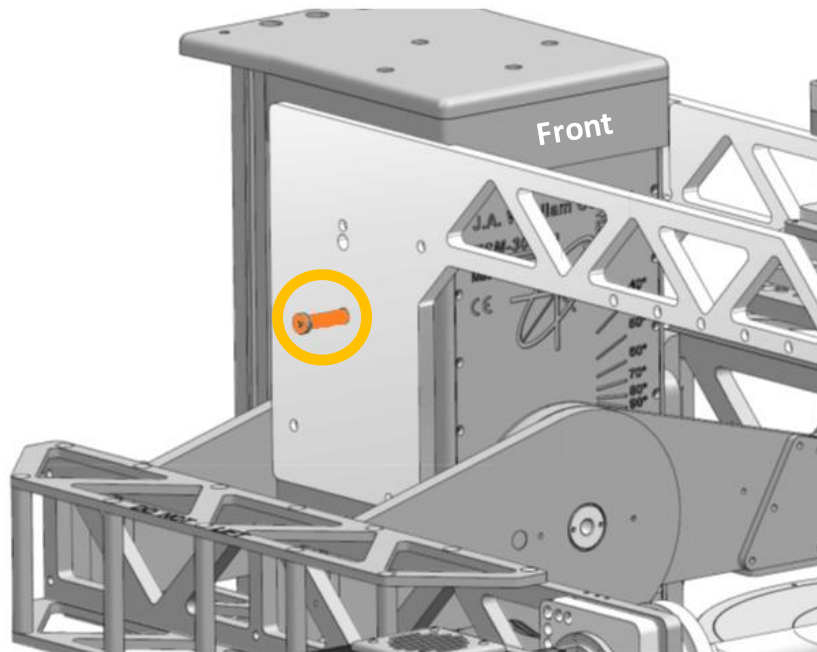


Figure 3-5. Angle of incidence locking screw.

3. Hold the arms at the center of the base to support the weight of the tower (lift slightly) and remove the Z-stage locking screw located on the right side of the base using a 4mm metric Allen wrench.

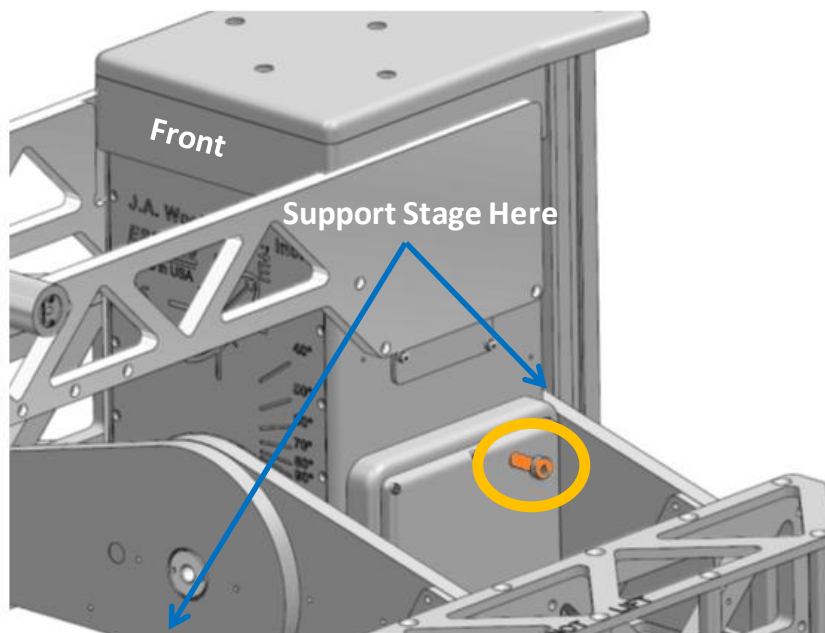


Figure 3-6. Z-stage locking screw.

4. For systems with automated sample translation, the translator shipping lock must also be removed.
 - i. Unplug the vacuum quick disconnect on the left side of the sample chuck assembly. Remove the sample chuck assembly by loosening the (4) black thumb screws. (2) are at the front of the sample stage and (2) are at the back of the sample stage.

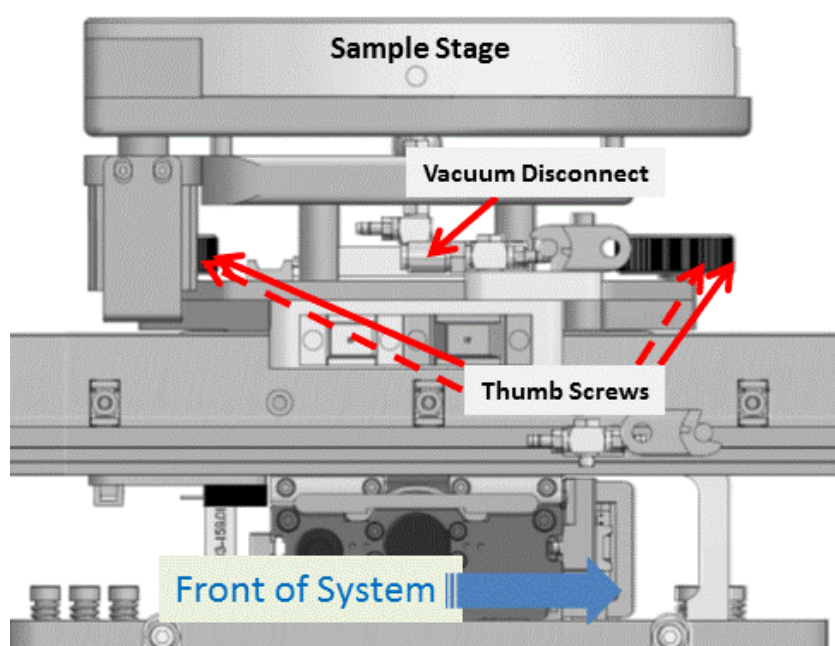


Figure 3-7. Vacuum disconnect and thumb screw locations.

- ii. Lift the sample chuck off of the translator.
 - iii. Remove the (6) SHC screws to remove the orange shipping lock. The top four require a 4mm metric Allen wrench, and the front/back two require a 3mm metric Allen wrench.

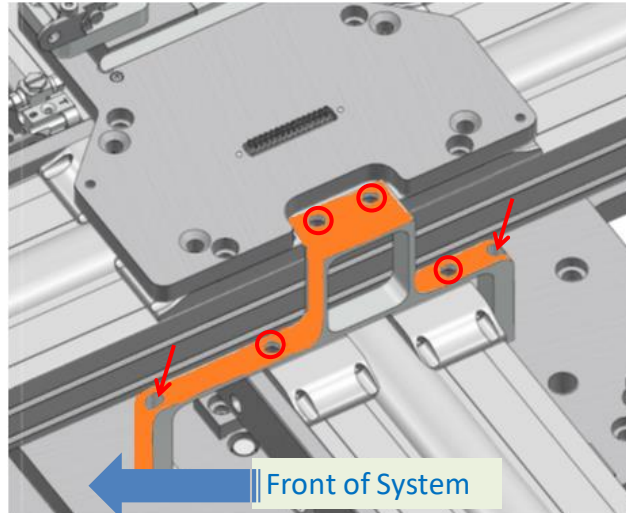


Figure 3-8. Removing the shipping lock.

5. Replace the sample chuck, tighten the (4) black thumb screws, and reconnect vacuum as shown in Figure 3-7.
6. Attach the source unit to the source tilt stage on the base using (4) M3 socket head screws with the cable connectors pointing to the rear of the base.

Source Tilt Stage



Figure 3-9. Source unit mounting (FQTH-100 Light Source shown).

7. Attach the receiver unit to the receiver tilt stage on the base using (2) M3 socket head screws with the cable connectors pointing to the rear of the base.

Receiver Tilt Stage



Figure 3-10. Receiver unit mounting (MQD Single Receiver Unit shown).

AC Wiring

Caution: When installing equipment, ensure that access to the power connection is unimpeded. In case of emergency, removing the power cable from the wall socket will de-energize the equipment and put it in a safe state.

1. Ensure all components are turned off before attaching AC power cords.
2. Attach the computer and monitor AC power cords to the surge suppressor.
3. Attach AC power cords to the EC box, and the M-2000 Detector and Lamp Power Supply Module.
4. Attach the other end of the AC power cords to the appropriately labeled jack on the surge suppressor(s).
5. Attach surge suppressor(s) to the AC power outlet and ensure it is switched ON.

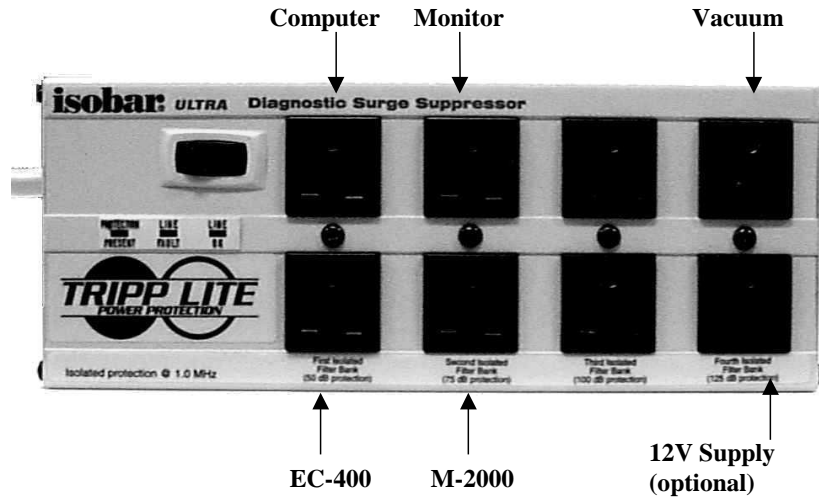


Figure 3-11. (110V AC) Configuration.

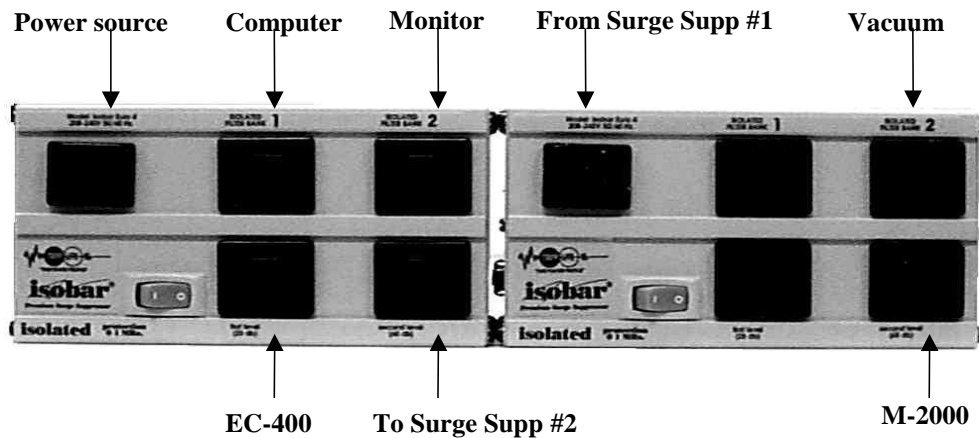


Figure 3-12. (220V AC) Configuration.

Caution: To avoid possible electric shock from small leakage current, ensure the protective earth conductor is properly secured to the building earth ground. DO NOT in any case bypass this ground conductor. It is essential to the safety of the equipment and its user.



Figure 3-13. EC Earth Ground Connection.

Cabling

Connect cables as directed in Table 3-1 and shown in Figure 3-14 (some options may not be available or applicable).

SYSTEM JACK LOCATION	CABLE PLUG LABEL	CABLE PLUG LABEL	SYSTEM JACK LOCATION
J1 (EC)	P1	P2	J2 (Source Unit)
J3 (EC)	P3	P4	J4 (Source Unit)
J5 (EC)	P5	P6	J6 (Receiver Unit)
J7 (EC)	P7	P8	J8 (M-2000)
J9 (EC)	P9	P10	J10 (M-2000)
J11 (EC)	P11	P12	J12 (M-2000)
J13 (EC)	P13	P14	J14 (Base Option)
J15 (EC)	P15	P16	J16 (Base Option)
J17 (EC)	N/C	N/C	Optional Aux. Port
J19 (EC)	P19	P20	J20 (Base Option)
J21 (EC)	RJ-45	RJ-45	Network Card in PC
J23 / J33 (M-2000)	P23 / P33	P24 / P34	J24 / J34 (Source Unit)
J25 (M-2000)	P25	P26	J26 (Receiver Unit)
J29 (EC)	P29	P30	J30 (System Option)
J31 (EC)	P31	P32	J32 (System Option)
J37 (EC)	P37	P38	J38 (System Option)
Computer USB	USB	P46	J46 (System Option)
UV (M-2000)	UV FIBER	UV FIBER	SMA UV (Receiver Unit)
IR (M-2000)	IR FIBER	IR FIBER	SMA IR (Receiver Unit)

Table 3-1. Cabling diagram.

Note: The IR fiber is only required for the NIR extension.

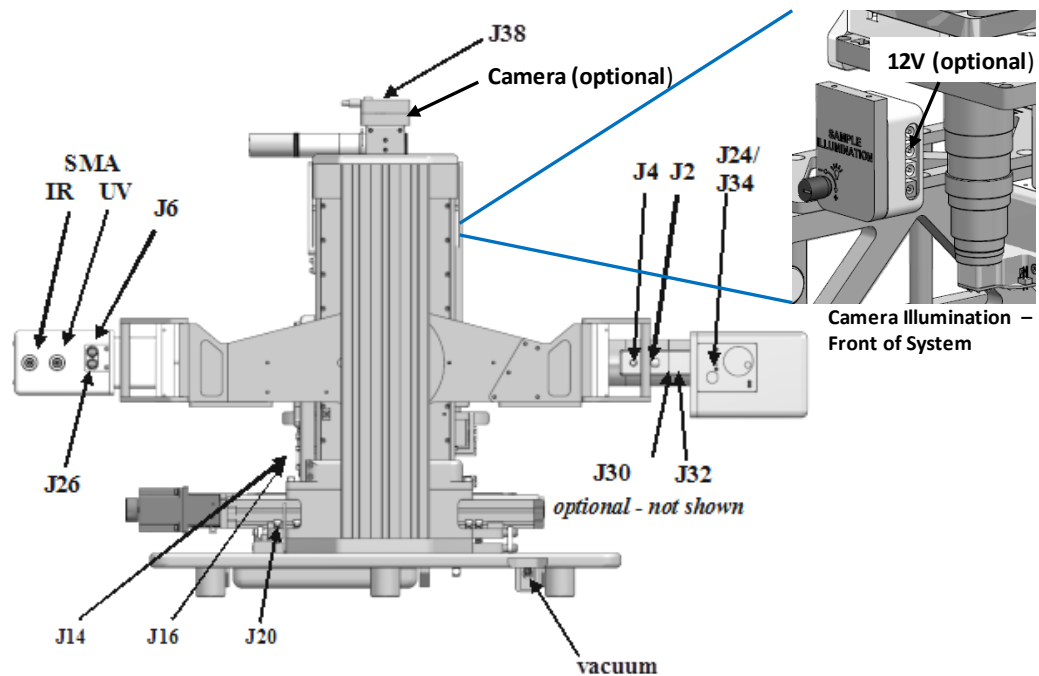


Figure 3-14. Connector locations.

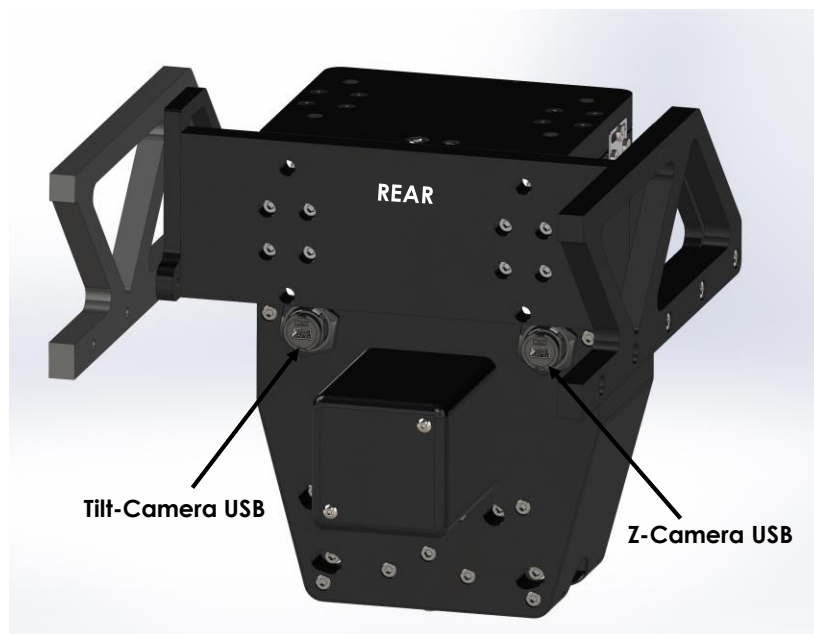


Figure 3-15. Lookdown Camera option.

Note: If the Camera(s) is USB 3.0 (USB-C connector), it MUST be connected to USB 3.0 or higher port on the PC.



Figure 3-16. Electronics Control rear view (example).



Figure 3-17. M-2000 Detector and Lamp Power Supply Module Rear View (example).

Computer

1. Attach the monitor cable to the computer.
2. Attach keyboard to the computer.
3. Attach the mouse to the computer.

Rack Mount Table Option

1. Secure the base unit to the table using the (4) screws provided.

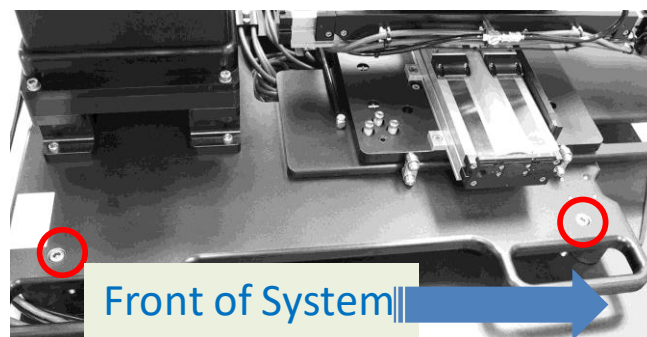


Figure 3-18. Mounting locations, left side.

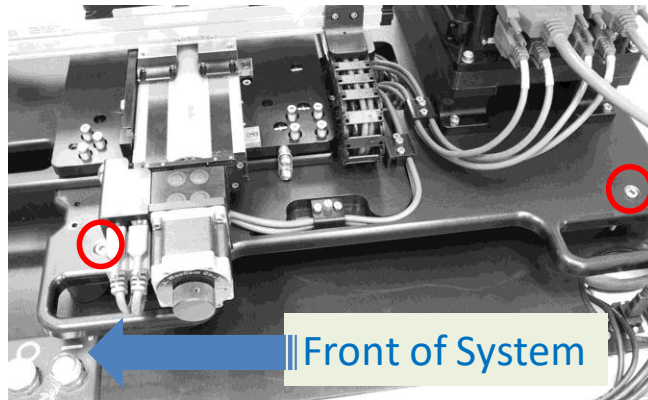


Figure 3-19. Mounting locations, right side.

2. Mount the monitor arm bracket to the table using (3) screws provided on the table.
3. Slide the keyboard, mouse, and monitor post onto the arm bracket.
4. Route the monitor power, monitor video, and USB hub cables through the cable ties on the arm bracket and plug into the appropriate location on the monitor.
5. Plug in the EMO Switch cable (DB-25) to the EMO box on the arm bracket.

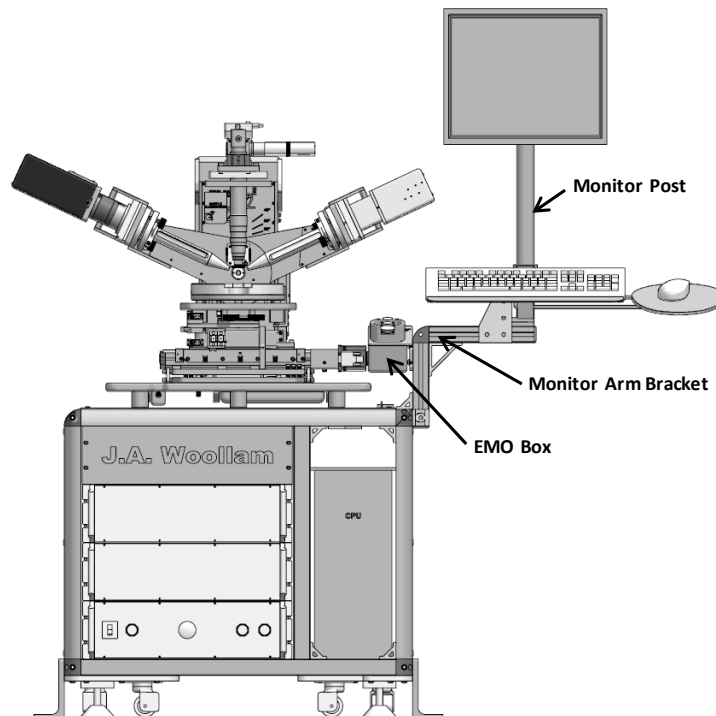


Figure 3-20. Assembled system (simulated).

AC Wiring (for Rack Mount Table Option)

Caution: When installing equipment, ensure that access to all E-Stop (EMO) buttons is unimpeded. In case of emergency, pressing the button will de-energize the equipment and put it in a safe state.

1. Ensure all components are turned off before attaching the AC power cord.
2. Attach a power cord protected by a 15 Amp breaker to the Power Control Module. This power cord may not be supplied and must have an IEC-320 C-13 plug on one end. The cord must be rated for at least 12A continuous.
3. Attach the other end of the AC power cord to the appropriately labeled jack on the surge suppressor. (See Figure 3-22 or Figure 3-23).
4. Attach surge suppressor to the AC power outlet and ensure it is switched ON.

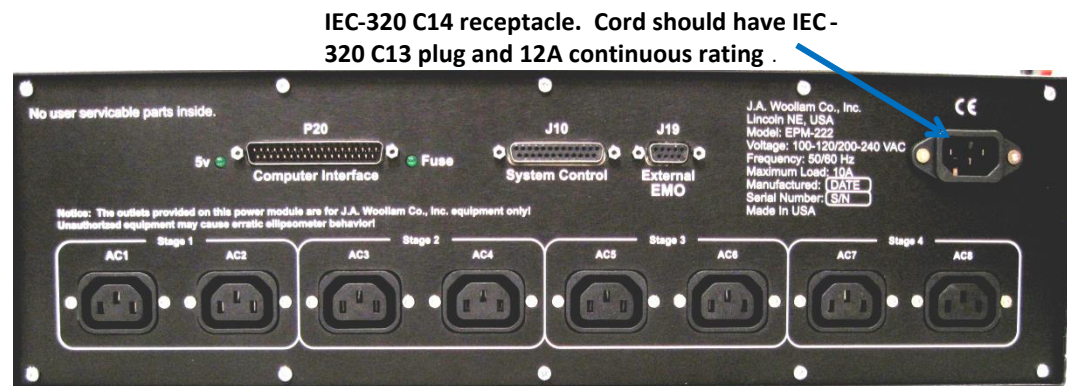


Figure 3-21. Power Control Module back panel.

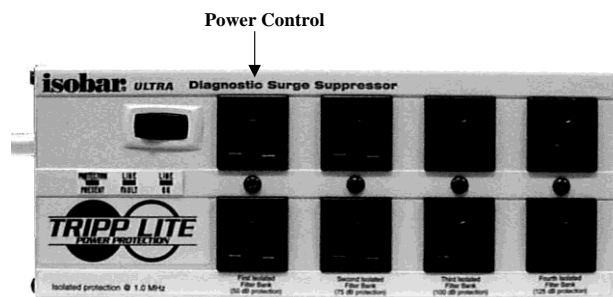


Figure 3-22. (110V AC) Configuration.

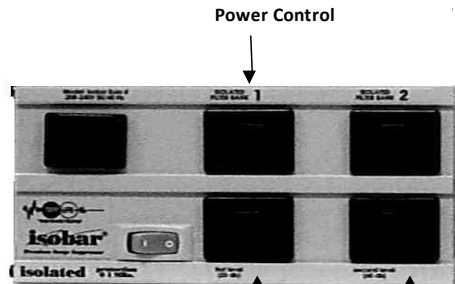


Figure 3-23. (220V AC) Configuration.

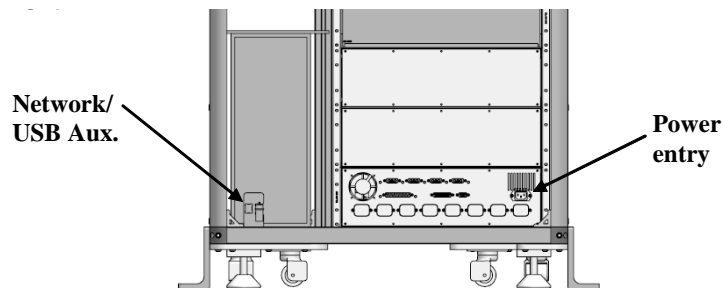


Figure 3-24. Rack Mount Table connector locations.

System Enclosure Option

If the enclosure option is supplied, follow these instructions to assemble/integrate.

1. Uncrate the entire system. Transport to final location.
2. Open the front door by lifting upwards by the handles as indicated.

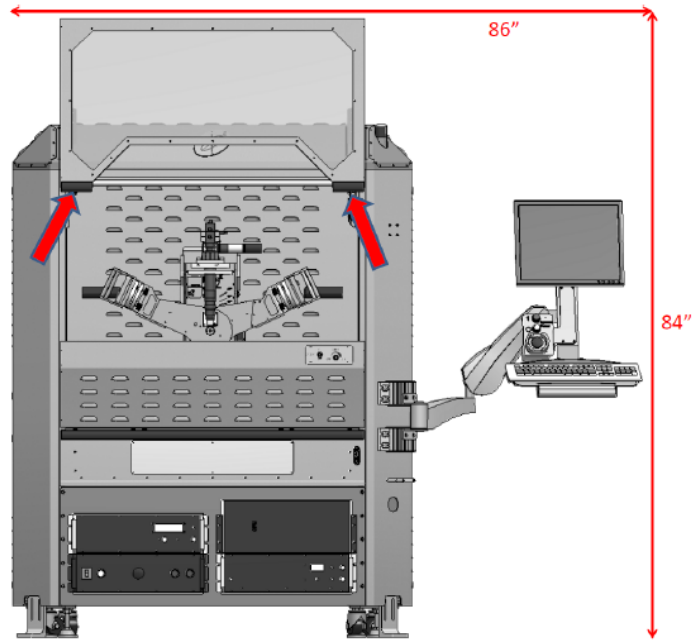


Figure 3-25. Open front door.

3. Remove top (2) side access panels and bottom rear panel by rotating cam latches counterclockwise at the corners of each panel using a flat screwdriver.

Note: The latch only needs to be rotated >1 turn to lock/unlock. Further rotation will change the latch depth and it may not catch the panel.



Figure 3-26. Panel latch operation.

4. Remove shipping restraints from the Base Unit. Install Ellipsometer and connect cables as described in previous section.

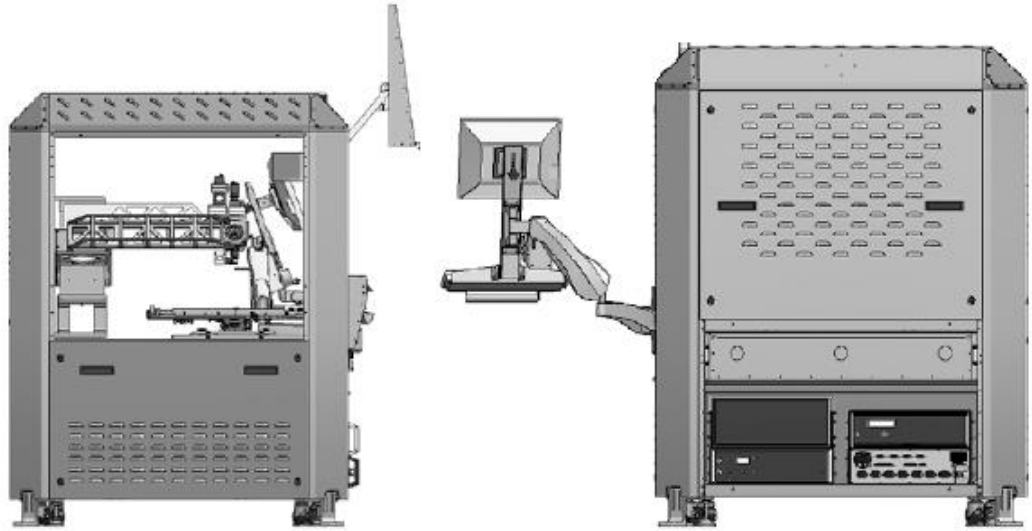


Figure 3-27. Panel removed for access to Base Unit.

5. Raise the light tree by first loosening the set screw from the access hole on the outside of the enclosure using a 3mm Allen wrench. Push up on the silver post from inside until all of the lights are exposed, and then re-tighten the set screw to lock in position.

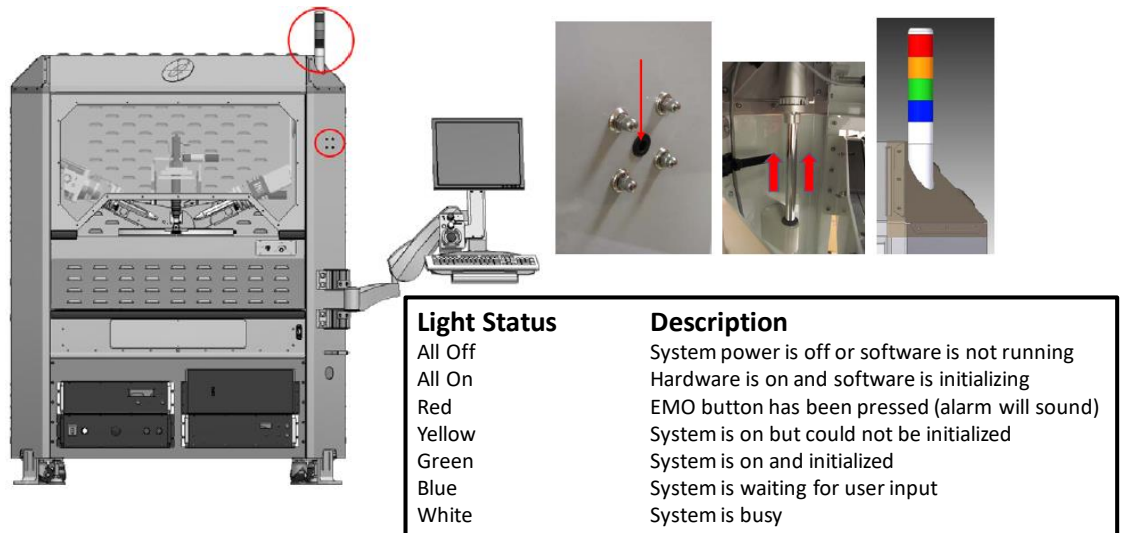


Figure 3-28. Light Tree and Status.

Monitor Arm Adjustment

Note: May vary based on model.

This is setup for safe and convenient use at the Factory. If adjustments are desired, below are brief descriptions. More detailed instructions are available on the Ergomart website (<https://www.ergomart.com>).



Figure 3-29. Monitor Tilt Adjustment.

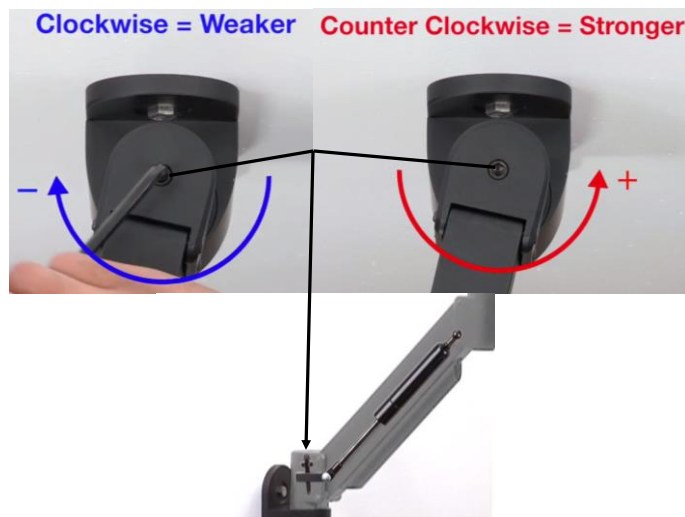


Figure 3-30. Arm height position tension.

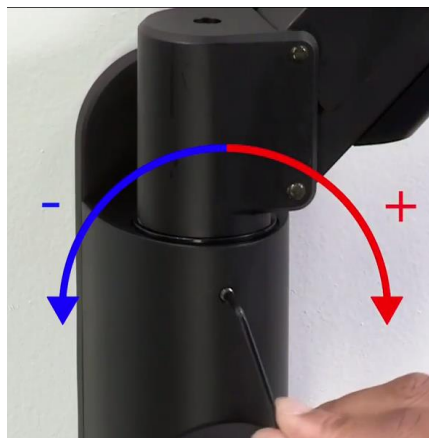


Figure 3-31. Arm swing tension.

AC Wiring (for System Enclosure Option)

Caution: When installing equipment, ensure that access to all E-Stop (EMO) buttons is unimpeded. In case of emergency, pressing the button will de-energize the equipment and put it in a safe state.

1. Ensure all components are turned off before attaching the AC power cord.
2. Attach a power cord protected by a 15 Amp breaker to the Power Control Module by routing through the 'Power Feed-thru' port. This power cord may not be supplied and must have an IEC-320 C-13 plug on one end. The cord must be rated for at least 12A continuous.

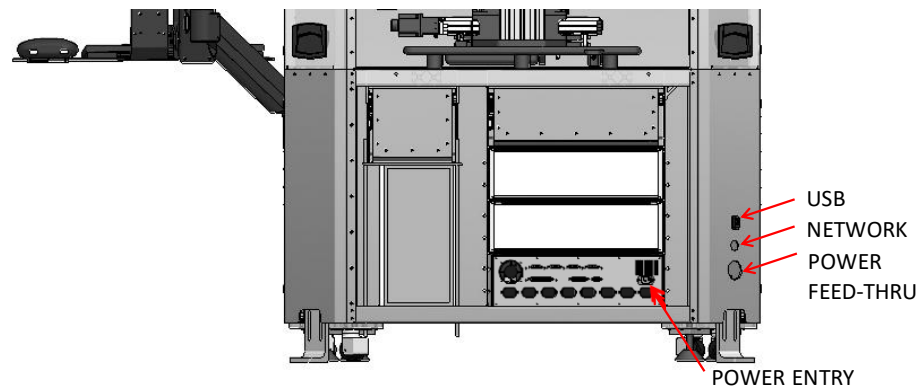


Figure 3-32. Enclosure back panel connections.

3. Attach the other end of the AC power cord to the appropriately labeled jack on the surge suppressor.
4. Attach surge suppressor to the AC power outlet and ensure it is switched ON.

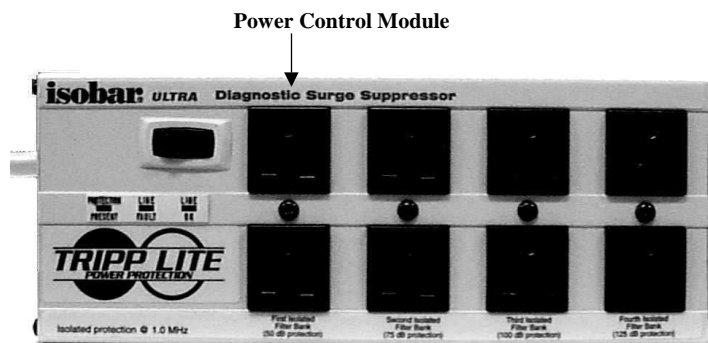


Figure 3-33. 110V AC Configuration.

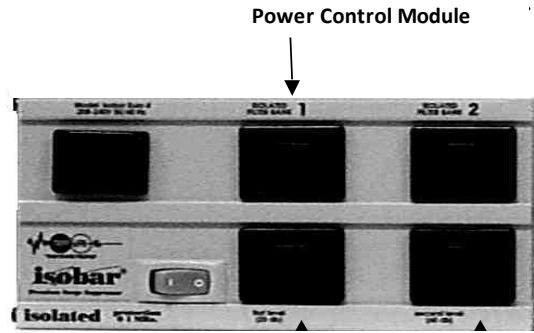


Figure 3-34. 220V AC Configuration.

5. Re-install bottom rear panel. System is assembled and ready for operation.

Caution: After performing System Alignment, be sure to re-install top (2) side access panels.

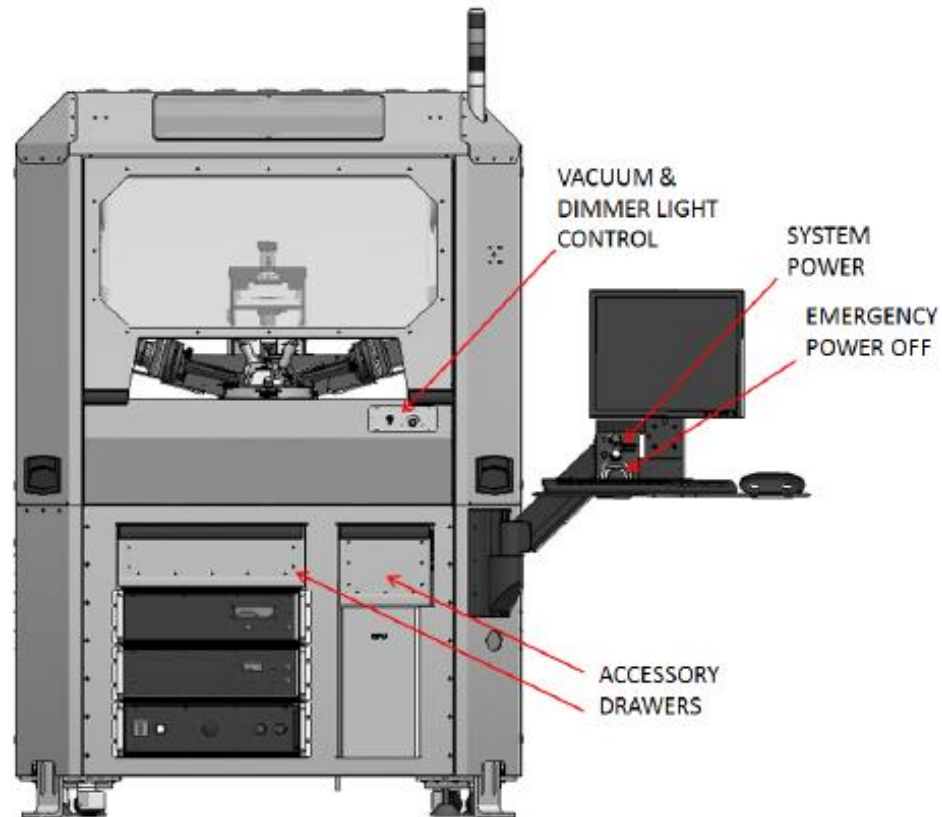


Figure 3-35. Assembled System – control summary.

Lamp Installation (if applicable)

The Xenon lamp housing requires the Xenon lamp to be removed during shipping. See Chapter 10 Scheduled Maintenance for instructions on installing the lamp.

3.2 Electronics Control (EC) Module Setup

The EC Module (and the network card in the PC if shipped with the system) has been configured at the factory and should not need to be changed. If components are repaired or replaced, the instructions below may be necessary.

Configuring the EC Module

Caution: Incorrect setup of the EC will prevent the system from operating. Only qualified personnel should change the TCP/IP address if it is necessary. Contact J.A. Woollam Co. if assistance is needed.

1. With the power off, press and hold the up and down arrows while turning the power on.
2. Release the buttons when the screen displays “Select Control Type:”

A monochrome LCD screen showing the text "Select Control Type:" on the first line and "Serial/TCP: TCP/IP" on the second line. The text is in a simple, pixelated font.

Figure 3-36. Selecting control type.

3. Press the up or down arrow key to select TCP/IP.
4. Press the right arrow key to enter.
5. Using the up or down arrow keys select the TCP/ IP address and use the right arrow key to enter.

A monochrome LCD screen showing the text "Enter TCP Address:" on the first line and "192:168:000:002" on the second line. The text is in a simple, pixelated font.

Figure 3-37. Entering TCP/IP address.

6. Now using the up or down arrow keys select the TCP/IP mask and use the right arrow key to enter.

A monochrome LCD screen showing the text "Enter TCP Mask:" on the first line and "255:255:255:000" on the second line. The text is in a simple, pixelated font.

Figure 3-38. Entering TCP/IP Mask.

7. The display will now ask “Control Type: TCP/IP?” Use the down arrow key to select yes.

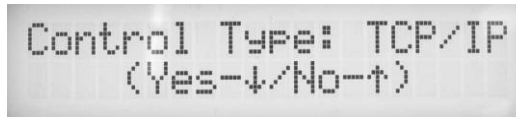


Figure 3-39. Verifying control type.

8. The display will now ask “TCP OK: xxx:xxx:xxx:xxx?” If it is correct use the down arrow key to select yes.



Figure 3-40. Verifying TCP/IP address.

9. The display will now ask “Mask OK: xxx:xxx:xxx:xxx?” If it is correct use the down arrow key to select yes.



Figure 3-41. Verifying Mask address.

10. The EC has now been setup for the TCP/IP address.

Note: The default TCP/IP address set at the factory is 192.168.000.002. The default Mask is 255.255.255.000. In order to establish proper communications between EC and the operator's PC, the network card in the PC must be set correctly also.

TCP/IP address in the hardware.cnf file

1. Using Notepad, open the hardware.cnf file located in the C:\CompleteEASE\cnf directory.
2. The line under the [Hardware] section should say 'Remote=TCP 192.168.0.2 300 0'
3. The first four numbers (192.168.0.2) need to be the same as the TCP/IP address on the EC box.
4. If a change is made, save the file, and changes will be in effect the next time CompleteEASE is started.

3.3 Operator Computer Setup

If the operator computer was not sent with the instrument, there are some additional steps required.

Software Installation

1. Install the software by following the on screen the instructions. See the **CompleteEASE Software Manual** for more details regarding installation and activation (if required).
2. Copy the configuration (*.cnf) files from the backup CD/Drive into the 'C:\CompleteEASE\cnf' sub-folder.

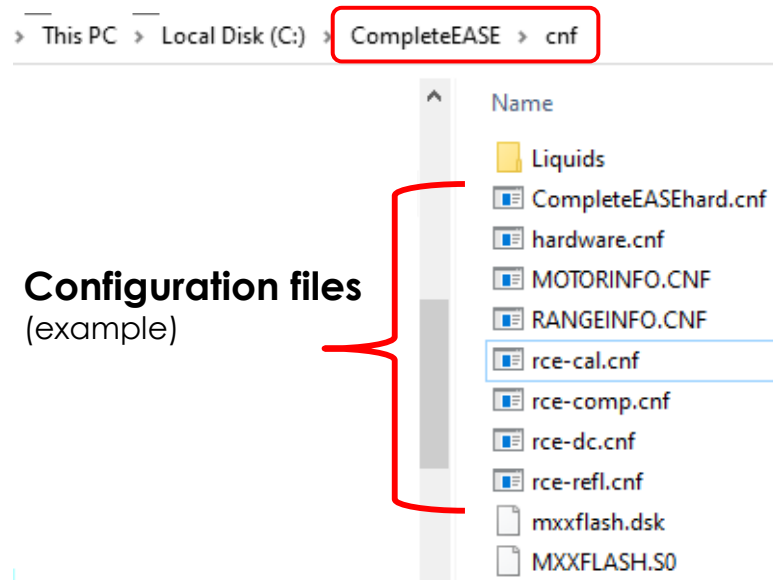


Figure 3-42. Configuration file location.

Windows Network Setup

Note: The Network Card address must be on the same subnet as the Ellipsometer address.

The Ellipsometer is connected via TCP/IP communication to the Windows Operator Computer. It is recommended that the instrument's computer be independent of any existing network. However, if it is necessary for the computer to be connected to an existing network, two separate network cards are required. One card to communicate with the network and another card to communicate with the ellipsometer locally.

Note: It is recommended to use the primary Network Interface Card (NIC) for the Ellipsometer connection, and then install the secondary card for any external network connections.

1. In Windows Network and Sharing Center (Control Panel), select '**Change adapter settings**' from the left-hand side pane.

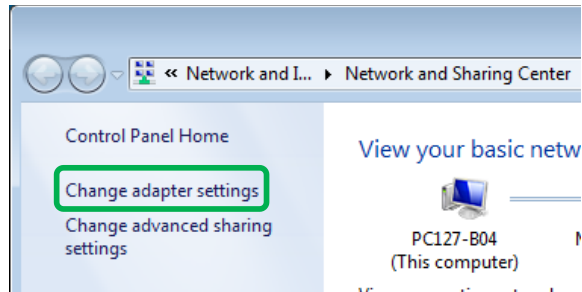


Figure 3-43. Change adapter settings.

2. Right-click the Network Card adapter, and then select **Properties**.

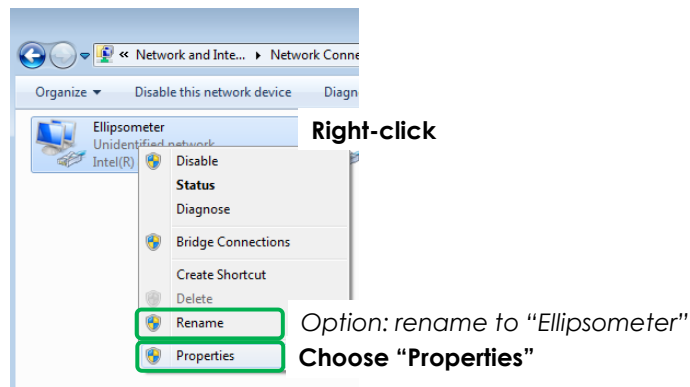


Figure 3-44. Select Properties.

3. Disable all items except **Internet Protocol Version 4 (TCP/IPv4)**.

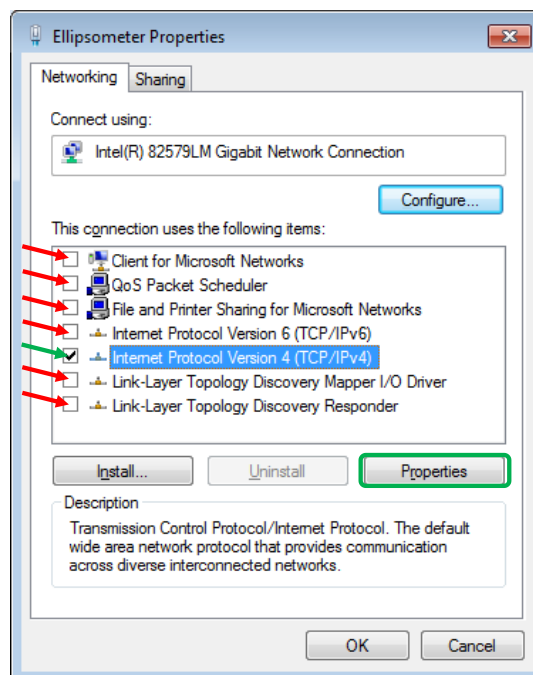


Figure 3-45. NIC Properties.

4. With Internet Protocol Version 4 (TCP/IPv4) selected, choose **Properties**.

5. Select **Use the following IP address** and enter in **192.168.0.1** with subnet mask **255.255.255.0** and select OK.

Note: If a secondary NIC is installed for another network connection, it should not be on the same subnet (192.168.0.X).

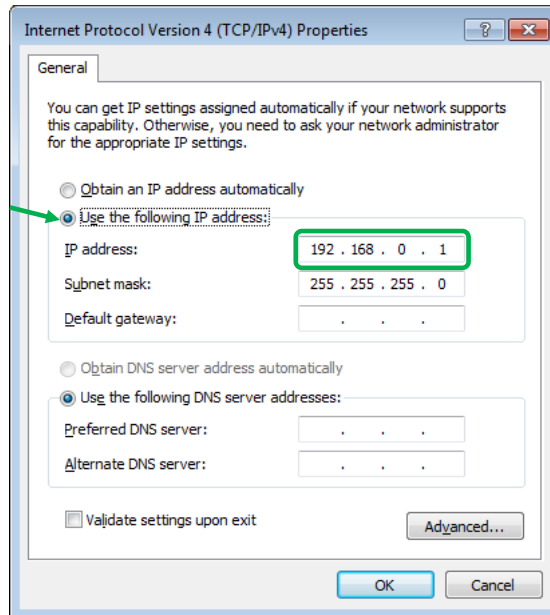


Figure 3-46. Internet Protocol Properties.

USB Camera

BIOS C-States Control

If equipped with a USB Camera(s), the “C-States Control” must be disabled in the PC BIOS.

Note: All computers are different and evolve over time. Consult the manufacturer service department to determine how to access the BIOS.

1. Restart the PC, and enter the one-time boot menu. Typically, by pressing F12 on the keyboard during the boot sequence.



Figure 3-47. One-time boot menu access (example).

2. Select the BIOS Setup, find the C-States Control Setting, and then disable.

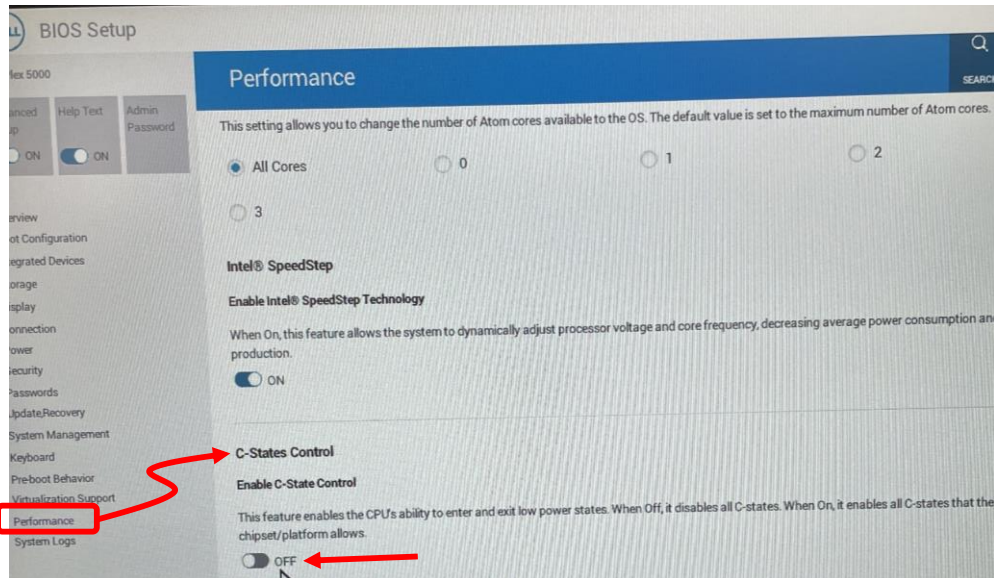


Figure 3-48. BIOS C-States Control (example).

USB 3.0 Camera Driver

If the Camera (Imaging and/or Alignment Camera) is a USB 3.0 Camera (USB-C connector), the Drivers must be installed to run.

1. Run the 'ids_peak_x.x.x.x.exe' installer from the CompleteEASE\jar\Drivers folder.

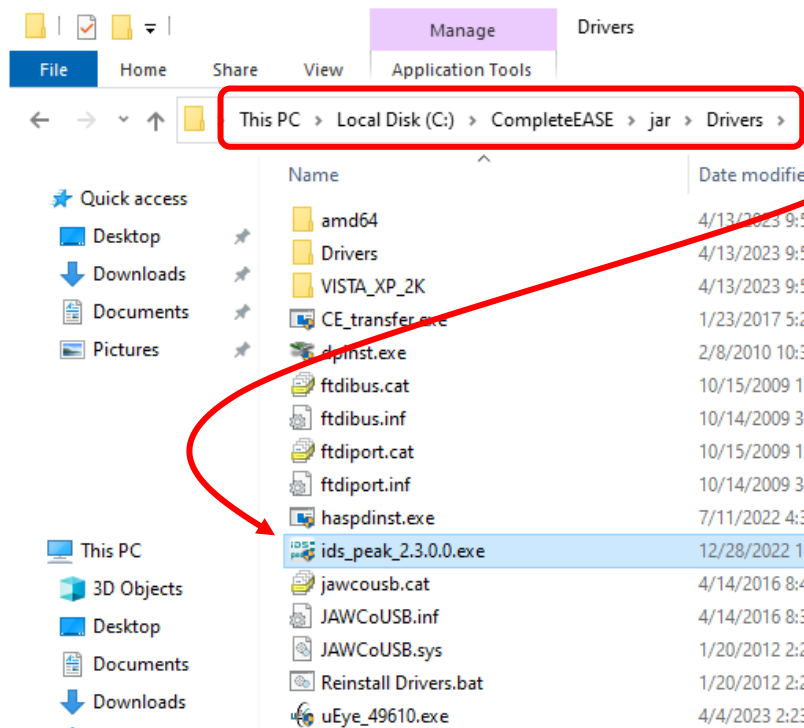


Figure 3-49. IDS camera driver installation.

2. When the installation is complete, a computer restart is required.

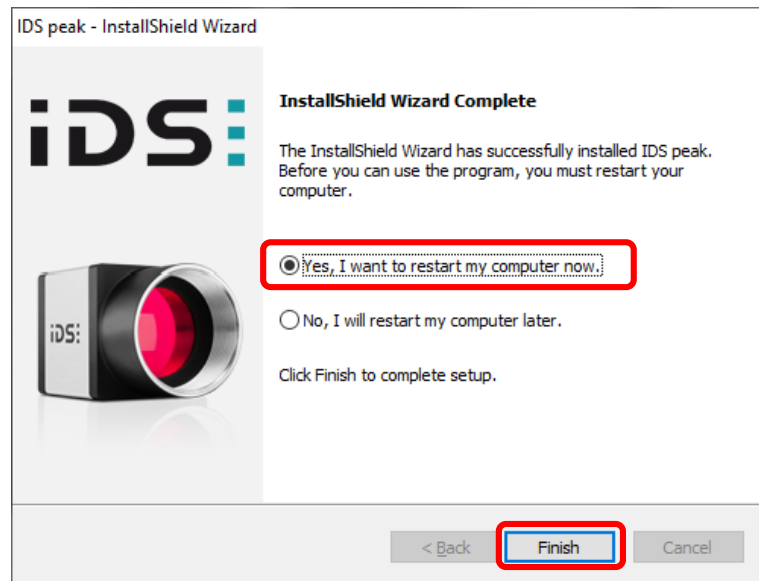


Figure 3-50. Installation completed – restart required.

3. There may be a shortcut created on the Desktop.

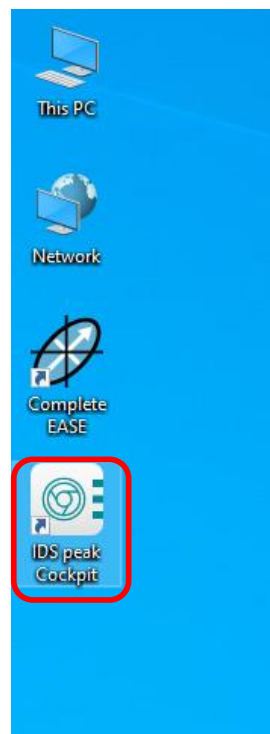


Figure 3-51. IDS software shortcut.

Note: It is a good idea to remove this to avoid launching the IDS program as CompleteEASE will not be able to connect the Camera(s) if this program is also running.

High Performance Mode

It is also recommended to set the Windows **Power Options** to High Performance. Hard Disk, Sleep, and Hibernate settings as shown below.

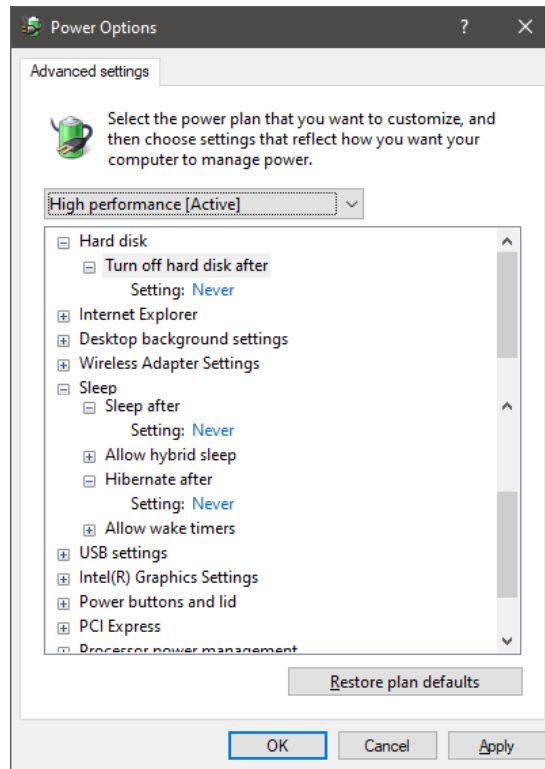


Figure 3-52. Power Options.

4 Preparing the System for Use

4.1 Power up Procedure

Turn on the components of the M-2000 system in the following order.

1. Turn on the lamp power supply button on the M-2000 module. Wait 3 seconds and press the ignition button (not applicable on M-2000V and VI systems). Hold a piece of paper in front of the Light Source unit to check that the lamp is on. Light may also be visible through a vent on top of the light source. If this intensity is weak, the lamp inside the lamp housing may need to be adjusted or replaced. This information can be found in Chapter 10 Scheduled Maintenance.

Note: Allow the lamp to warm up for at least 15 minutes.

2. Turn on the EC box.
3. Turn on the monitor and the computer (will turn on automatically with power on a rack mount table system).
4. Double click the CompleteEASE program icon (or highlight the title bar under the CompleteEASE program icon and press <enter>). A status message will appear on the screen showing the initialization progress.
5. After the hardware is successfully initialized, the software will display “Waiting to Acquire Data” in the Hardware Status panel. If the hardware initialization is not successful, note the error messages that are displayed, and consult Chapter 12 Troubleshooting.

4.2 Conventions Used in this Manual

The following conventions are used to describe features in the CompleteEASE software, in order to help the user navigate this manual.

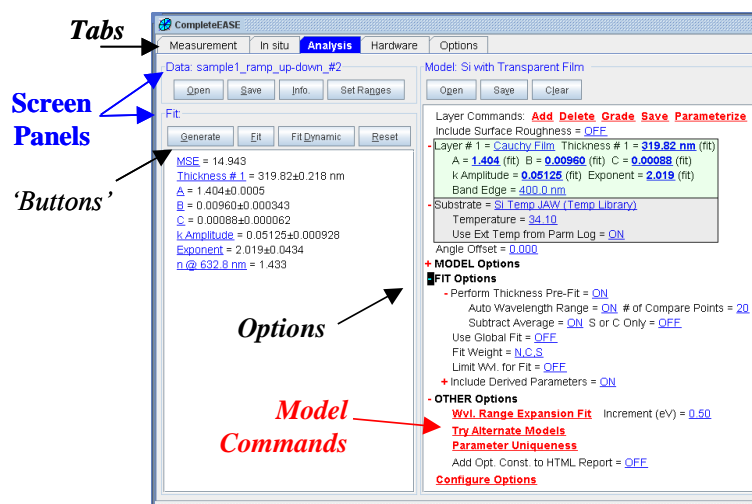


Figure 4-1. Software conventions.

Tabs such as **Measurement** and **In Situ** will be written in bold italics.

Screen Panels such as **Data**, **Fit**, and **Model**: (in the **Analysis** Tab above) will be written in bold, blue text.

'Buttons' such as 'Open' and 'Save' (in the **Analysis** Tab above) will be designated with single quote marks.

Model Commands such as **Parameter Uniqueness**, which are found in the **Model**: panel will be written in bold, underlined, red letters.

+FIT, **+MODEL** and **+OTHER** Options found in the **Model**: panel will be written in bold black letters. The symbol preceding the text shows whether that section is collapsed (+) or expanded (-).

Mouse-selected menus are indicated with (⌘R) or (⌘L) for Right and Left mouse-buttons, respectively.

"Pipeline" descriptions of command selections: Command selection sequences will be described as a "pipeline" in this order: **Tab**>**Panel**>'Button', (⌘R), etc. For example: the 'Open' button within the **Model**: panel under the **Analysis** tab is described as

Analysis>**Model**:>'Open'

A more extensive discussion of CompleteEASE software features is available in the CompleteEASE Data Analysis Manual, Section 1.3.

4.3 File Organization & Manipulation

The CompleteEASE software is installed on the hard-drive in a single directory. Within the CompleteEASE folder, there are several default subdirectories \DAT, \MAT, \MOD, \cnf and \jar. Users can also add their own directories.

A more extensive discussion of the CompleteEASE file structure, as well methods to save and manipulate files, can be found in the CompleteEASE Data Analysis Manual, Section 1.4. The CompleteEASE Data Analysis Manual can be viewed by selecting **Options>Miscellaneous>'Show Manual'**

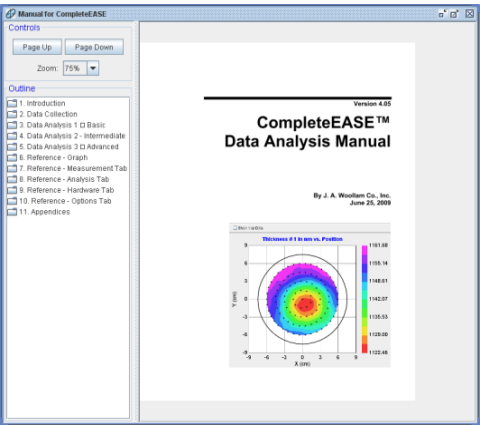


Figure 4-2. CompleteEASE Data Analysis Manual.

4.4 Operation

The typical ellipsometric measurement involves the following steps:

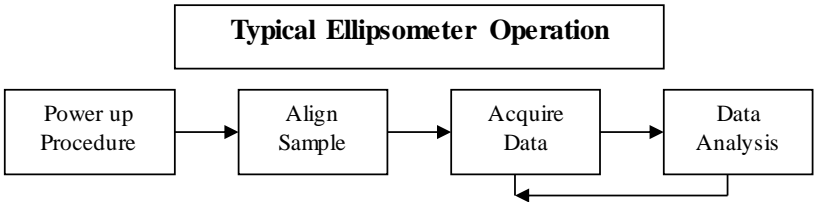


Figure 4-3. Flow chart.

The following definitions should be understood before operating the system:

System Alignment

System alignment is the adjustment of the Light source and Receiver components relative to the base of the M-2000 system (in the “straight-through” configuration). The straight-through configuration is when the angle of incidence is set at 90°; the beam of light will directly enter the receiver (the sample is not needed in this case). It also refers to the "Lookdown" detector alignment for the Auto Tip/Tilt option. It is required when the system is first delivered, when first mounting the system onto the base, or whenever the integrity of the alignment is in question.

Alignment with Filter Wheel Option

When performing the system alignment using a filter wheel, there are some factors to consider. Since the straight-through position is included in the calibration, the signal needs to be optimized throughout the entire spectrum. If a higher density filter is selected, the DUV signal is lower with respect to the overall average signal. As shown in Figure 4-4 and Figure 4-5, if a lower density filter is selected and the iris(es) or filter position on the Receiver unit is closed down to avoid ‘Overload’, the DUV signal is optimized. This results in a much better calibration result at these lower wavelengths. This procedure also applies to sample alignment for highly reflective samples (ex: Silicon wafer).

Examples of Source ND filter wheel positions vs. Signal Intensity:

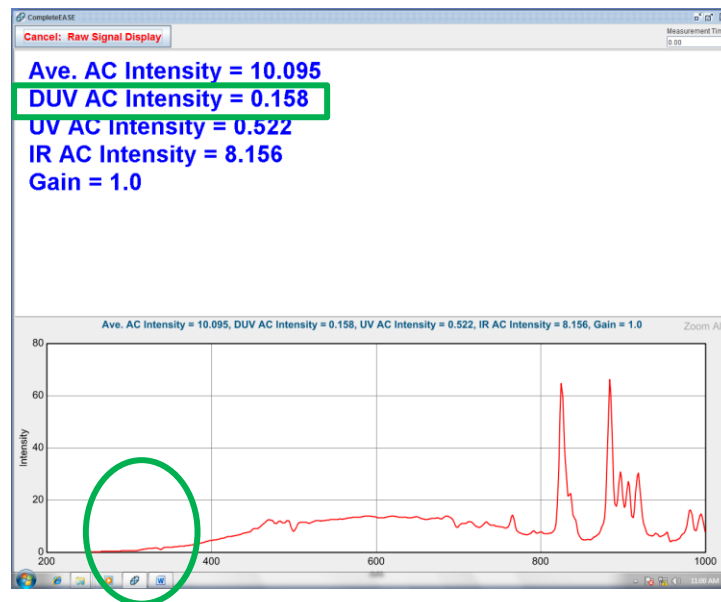


Figure 4-4. Filter position 6 with iris open.

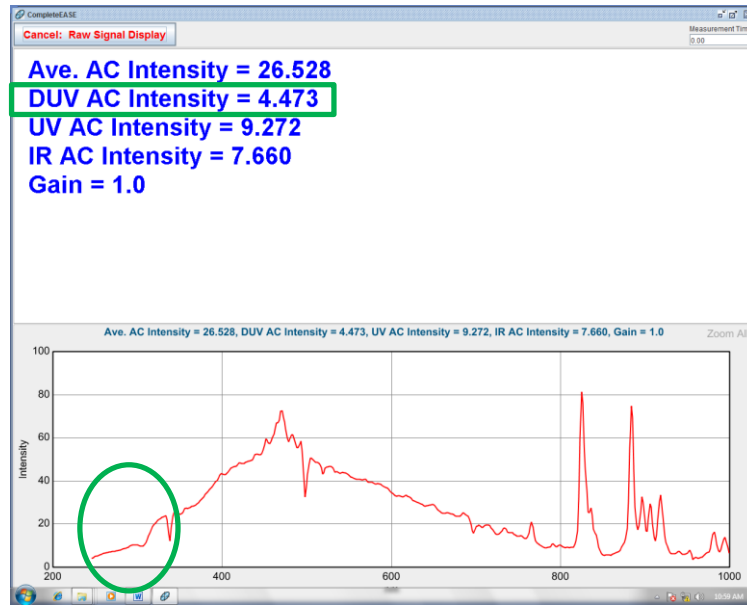


Figure 4-5. Filter position 4 with iris closed to avoid overloading the spectrometer.

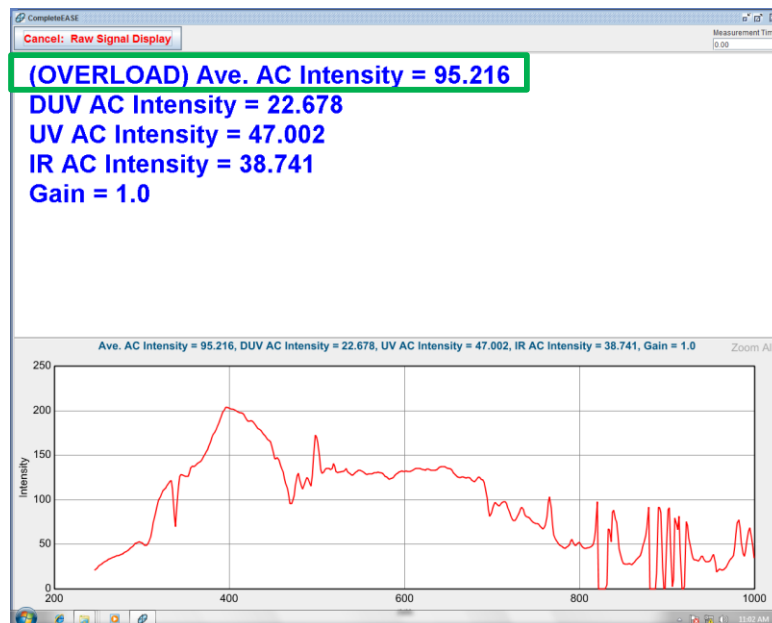


Figure 4-6. Overloaded spectrometer.

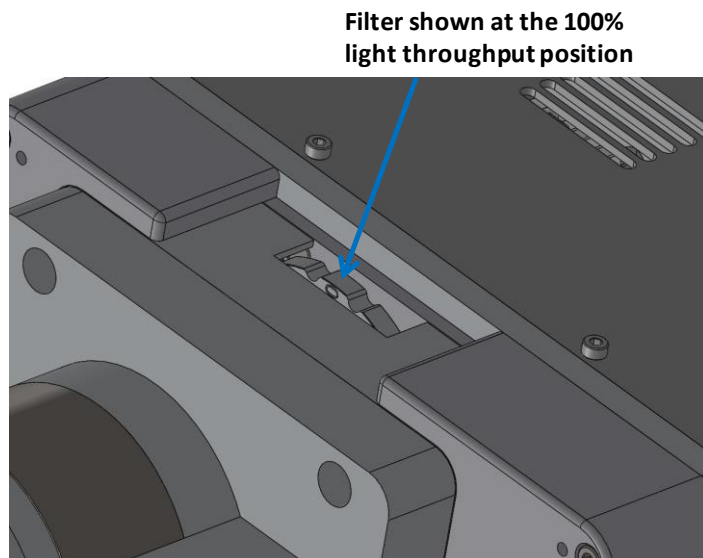


Figure 4-7. Xenon Source Unit Filter Wheel Option.

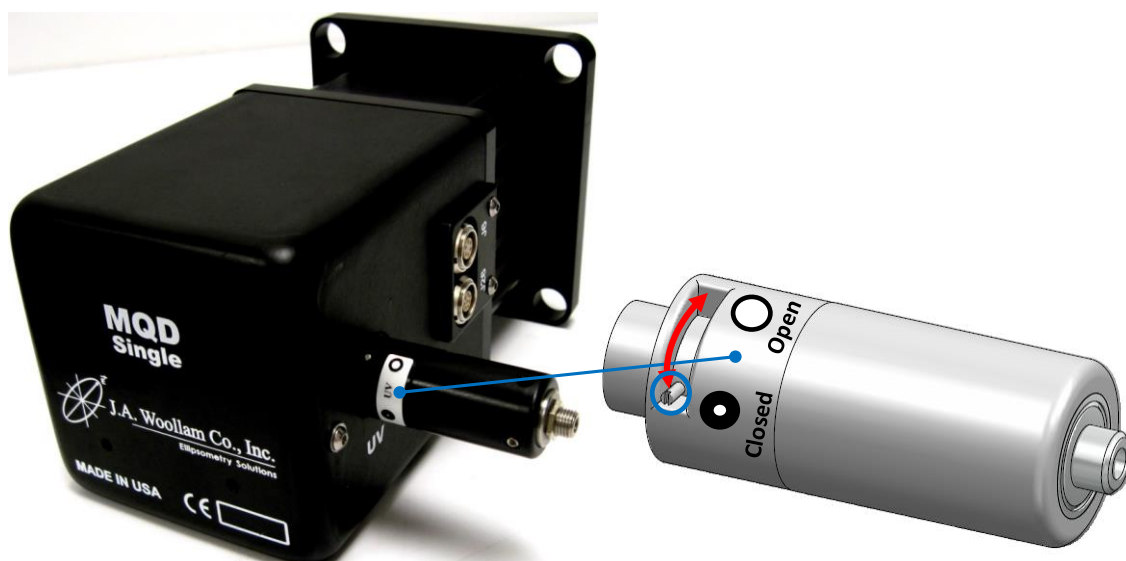


Figure 4-8. MQD-Single Receiver unit iris.

The MQD-Dual may be equipped with a manual ND filter wheel option that has four (4) detent positions for each fiber coupler to optimize the Intensity for each Detector:

POSITION	INTENSITY
I	100%
II	70%
III	50%
IIII	20%

Table 4-1. Manual Filter Wheel positions.

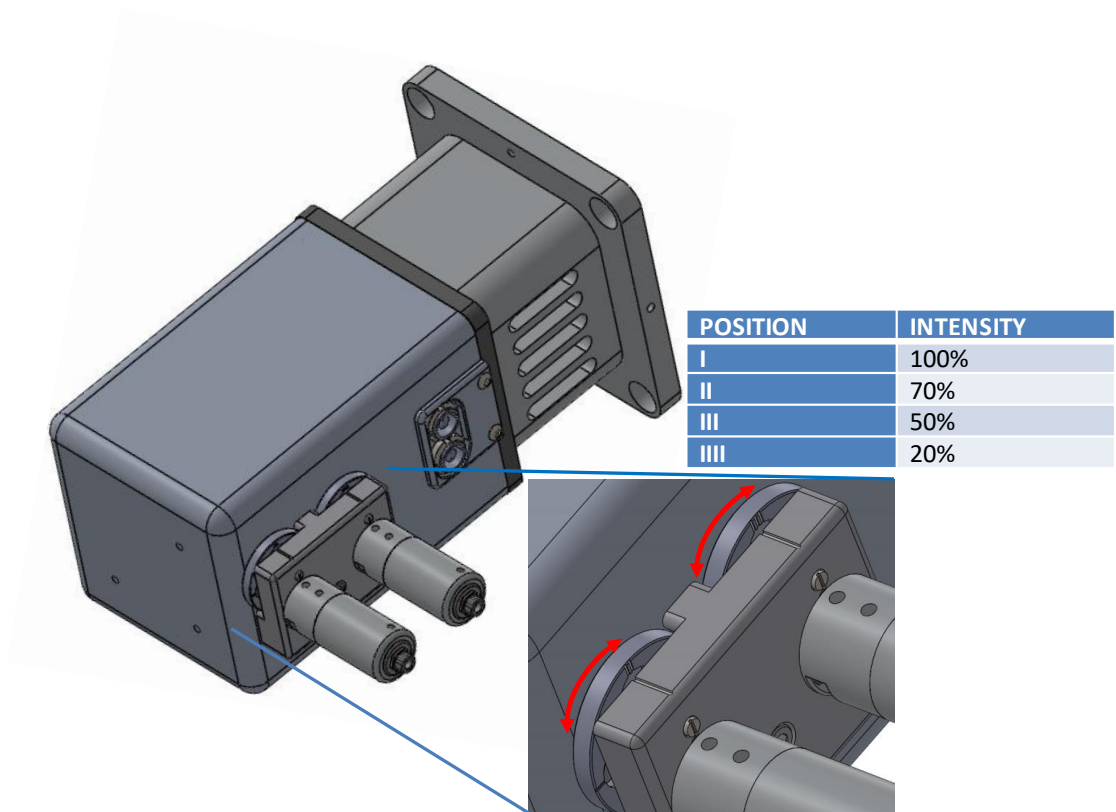


Figure 4-9. MQD-Dual filter wheel selection.

Sample Alignment

Sample alignment is required for each new sample to align the sample surface with respect to the ellipsometer. This is done by adjusting (manually or automatically) sample chuck tip/tilt and Z-Height.

System Check (Calibration)

A System Check must be performed every time the M-2000 hardware is re-mounted on the ex situ base or in situ chamber. This is required to determine the azimuthal angles of the polarizer, compensator, and analyzer optical elements with respect to the plane of incidence. This step also determines the in-plane and out-of-plane window effects when the system is mounted on a chamber with windows present. The system will automatically fit the data to the calibration wafer model. This confirms that the ellipsometer is working properly.

4.5 System Alignment (with Manual Tip/Tilt)

Note: Automated Tip/Tilt alignment is an optional accessory that may or may not have been purchased with your system. If your purchase included Automated Tip/Tilt, please see Section 4.6 for System Alignment (with Automated Tip/Tilt).

System alignment is the adjustment of the source and receiver components relative to the variable angle base of the M-2000 system. It is required when the system is first delivered, when first mounting the system onto a base or chamber, or whenever the integrity of the alignment is in question. Figure 4-10 shows the basic components of the M-2000 system, and this naming convention will be followed throughout these instructions.

In the straight-through position (angle = 90°), the white light beam should be centered on both the Receiver Unit aperture and the 4-quadrant alignment detector that is located inside the Receiver Unit. This alignment is easily tested, using the following instructions, which also describes correction to the alignment. All operations will be performed from within the **Hardware** tab of CompleteEASE.

Note: A System Alignment should only be performed when the instrument is first delivered, after mounting the Light Source and Receiver components onto a base or chamber, or if the integrity of the alignment is in question.

Note: Alignment of the Light Source and Receiver tilt stages on the base should only be adjusted when the base is in the straight-through position. Any adjustment screw should never need to be turned more than ½-1 full turn. If so, it is likely something is not mounted/aligned properly; check previous steps to be sure they were done correctly.

Note: Optional focusing optics must be removed before continuing (if attached).

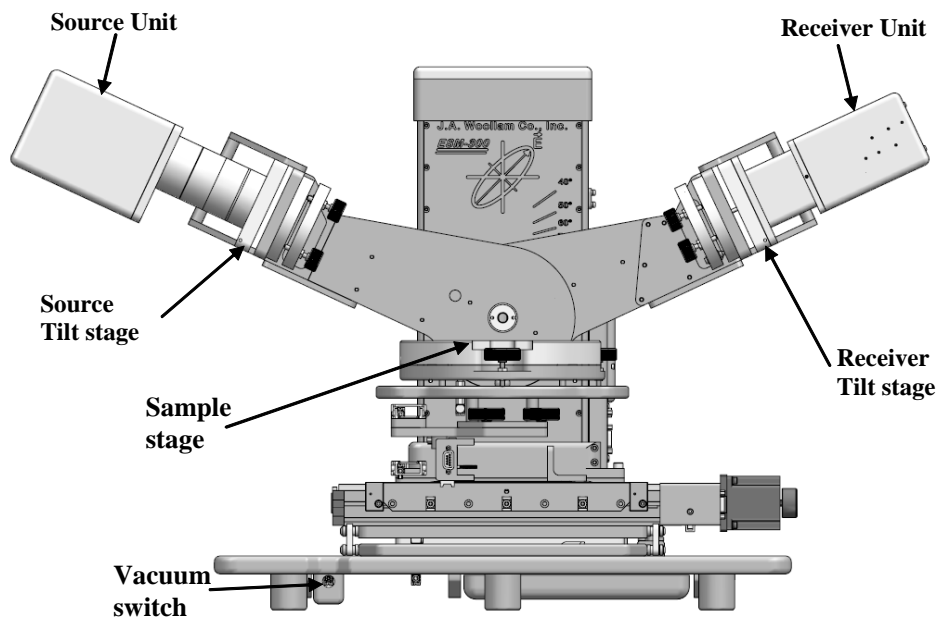


Figure 4-10. Nomenclature.

Source Unit Alignment

The lamp is housed inside the Source Unit, which is mounted to the system with tip-tilt adjustment (Source Tilt Stage) to manipulate the beam direction. The source beam alignment is verified in the straight-through position to ensure that it is aligned on the Receiver Unit aperture.

1. Select **Hardware>Controls>System>'Angle'**. Choose an Angle of 90°. The base will move to the straight-through position.

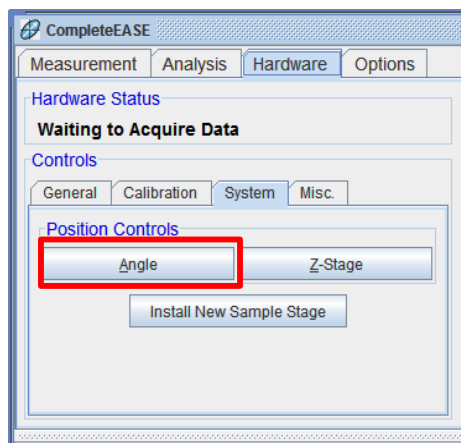


Figure 4-11. Angle button.

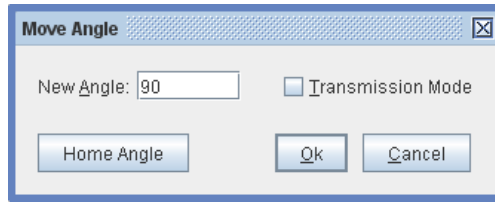


Figure 4-12. Move Angle dialog box.

2. Select **Hardware>Controls>System>'Z-Stage'**. Choose 18mm. This raises the Source and Receiver optics above the Sample Stage, so the beam can be viewed traveling to the Receiver Unit. If in a well-lit room, it may be difficult to view the light beam. Reduce room lights for next step of operation.

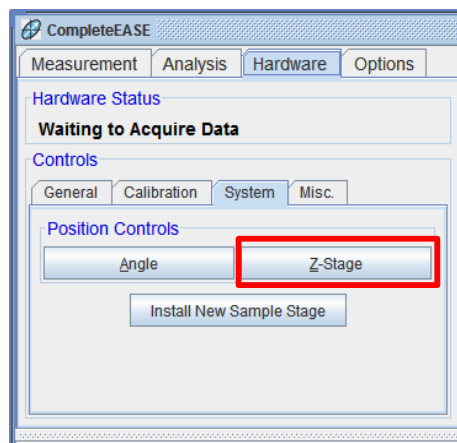


Figure 4-13. Z-Stage button.

3. Move your eye close to the Source Unit to view along the same path as the beam. This will allow you to see the beam entering the Receiver Unit aperture as shown below.
4. If the beam is not centered, center the probe beam on Receiver Unit aperture by adjusting the Source Tilt Stage using a 3.175mm (1/8") English Allen wrench. When the beam is aligned, there should be a uniform white halo around the aperture (shown below). Misalignment results in a "crescent" halo that is larger on one side of the black aperture.

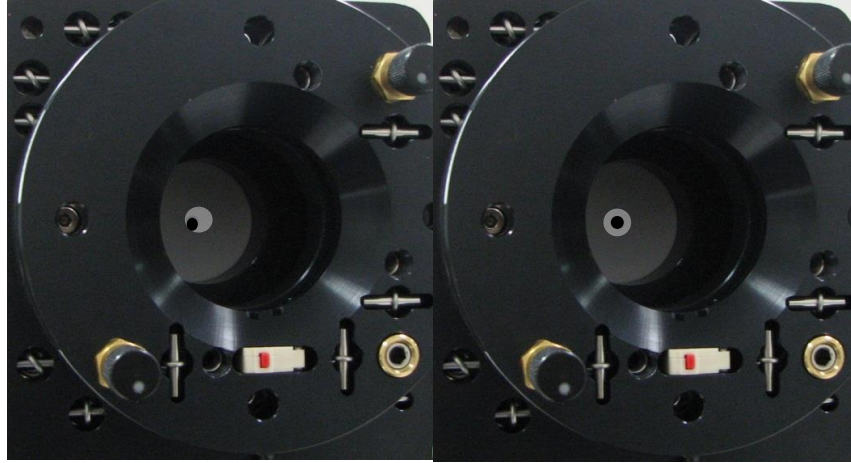


Figure 4-14. Centering the beam on Receiver Unit aperture.

Receiver Unit Alignment

After the Source Unit alignment has been verified, the light beam will be centered on the front aperture of the Receiver Unit. However, this does not ensure alignment through the Receiver Unit. The tip-tilt of the Receiver Unit controls its optical axis and makes sure it is collinear with the beam as it travels through the Receiver Unit. To verify alignment, a 4-quadrant alignment detector is located inside the Receiver Unit. In this section, we will verify alignment and adjust the Receiver Unit to the measurement beam if necessary.

1. Select **Hardware>Controls>General>'Align Sample'**. The software will ask "Would you like to perform a full sample alignment?" Select 'No'.

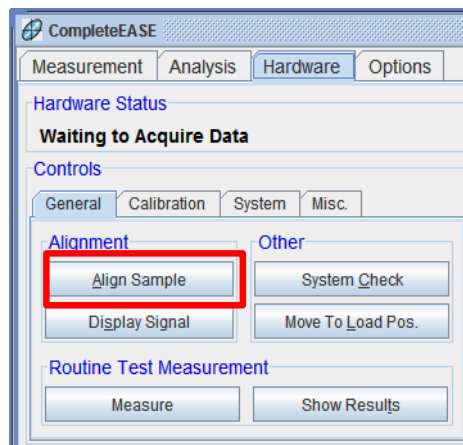


Figure 4-15. Align Sample button.

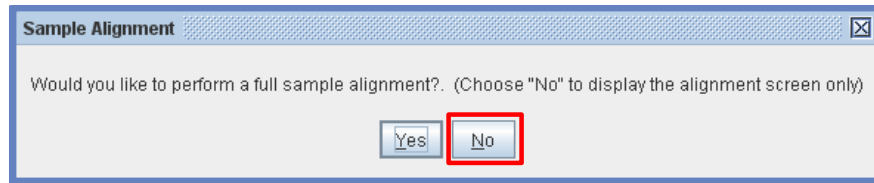


Figure 4-16. Sample Alignment dialog box.

Note: The following alignment screen is a generic screen shot. Refer to the system test report for your specific intensity values.

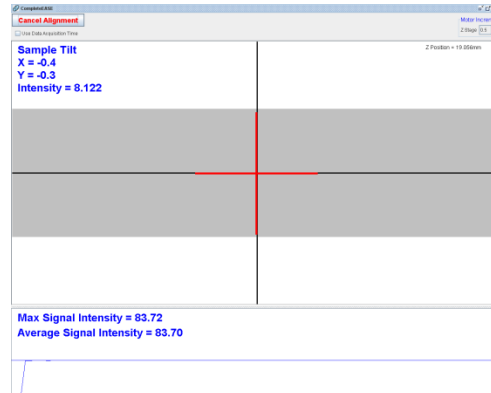


Figure 4-17. Alignment Screen.

2. The alignment screen shows gray areas to represent the intensity reaching each of the 4-quadrants of the detector, with a cross hair to show the position of the light beam inside the Receiver Unit.
 - a. If the Receiver Unit has the optional Internal Alignment Camera, there is no “gray area” but the cross hair positioning is still valid.

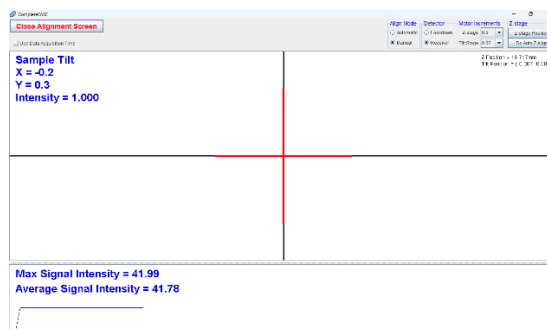


Figure 4-18. Alignment Screen – Receiver Camera.

- b. The Alignment Camera image can be viewed by selecting **Hardware>Controls>Misc>'Additional Hardware Functions'**.

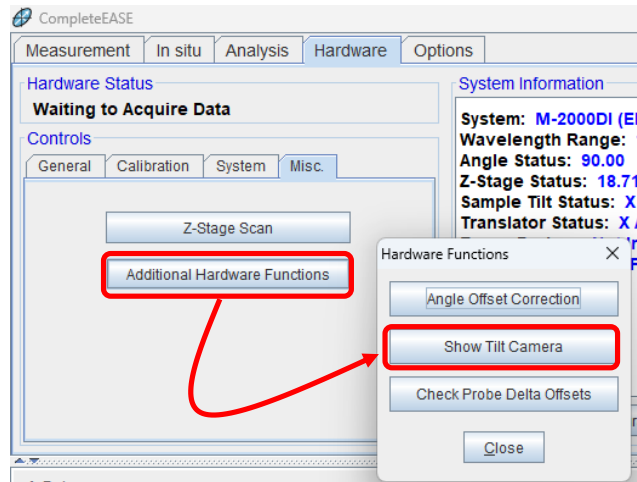


Figure 4-19. Show Tilt Camera button.

3. If the cross hair is not centered, adjust the Receiver Tilt Stage using a 3.175mm (1/8") English Allen wrench until the cross hair is centered on the alignment screen. Now, the beam should be aligned at both the front aperture and throughout the Receiver Unit. If the beam is no longer centered on the receiver aperture, repeat Source Unit and Receiver Unit alignment.
4. Press Escape or click 'Cancel Alignment' when finished.

Verify Signal

Inside the Receiver Unit, the light is directed into a fiber optic cable(s) which carries the light to the Spectrometer(s).

1. View the signal reaching the Spectrometer by selecting **Hardware>Controls>General>'Display Signal'**.

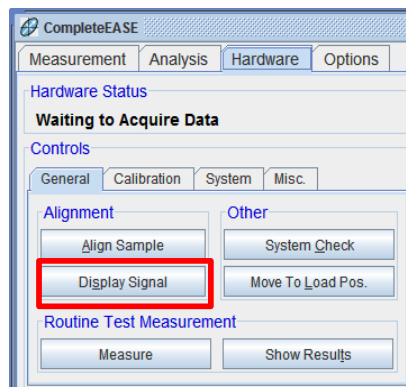


Figure 4-20. Display Signal button.

2. This will display a plot of the magnitude of the signal from all detector channels, as shown in Figure 4-21. The intensities below are typical for an M-2000 in the straight-through configuration.

Note: The following signal screen is a generic screen shot. Refer to the system test report for your specific intensity values.

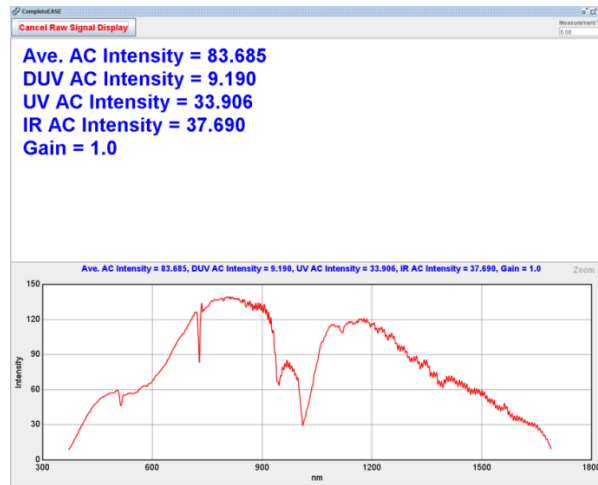


Figure 4-21. Raw Signal Display screen.

3. Check the value of the Gain displayed at the top of the signal intensity screen. In the straight-through position, the gain should be either 1 or 2. Otherwise, the system is not aligned properly or the lamp needs to be replaced and/or aligned. For your specific M-2000 intensity distribution of all channels please refer to the system test report. A hard copy is shipped with each system and a soft copy is included on the backup CD.
4. If part of the UV-VIS signal, optional NIR, or both is “Overloading” as shown in Figure 4-22, the iris(es) or filter position on the Receiver unit may need to be closed down until the signal is no longer “Overloaded” as shown in Figure 4-21. If the system is equipped with the Source ND filter wheel, this can also be adjusted to avoid the overload (see Neutral Density Filter Wheel section, page 16).

Note: The following signal screen is a generic screen shot. Refer to the system test report for your specific intensity values.

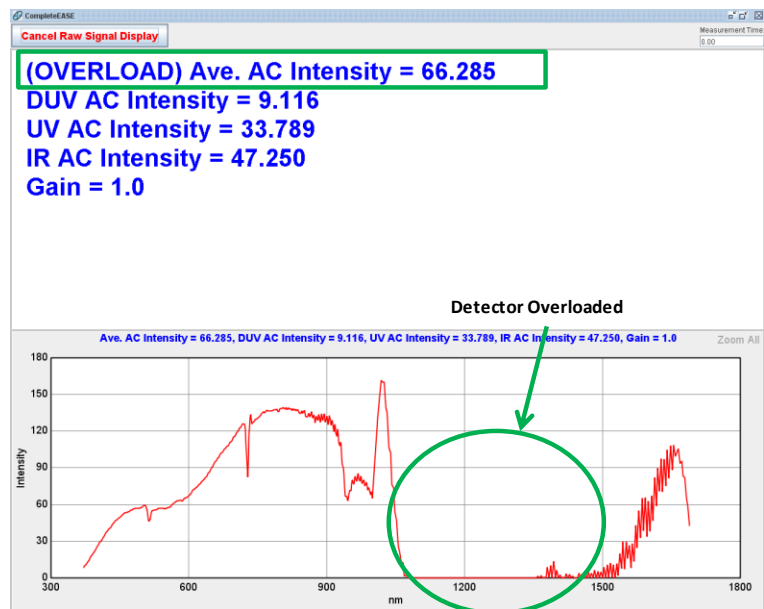


Figure 4-22. Optional NIR spectrometer overloaded on M-2000 system.

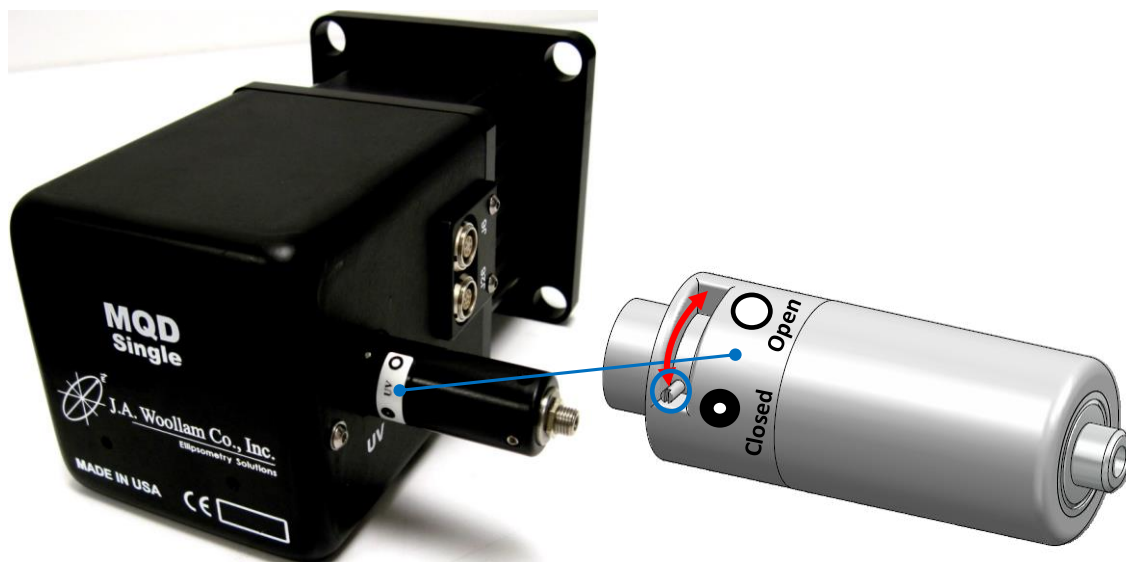


Figure 4-23. MQD-Single iris operation.

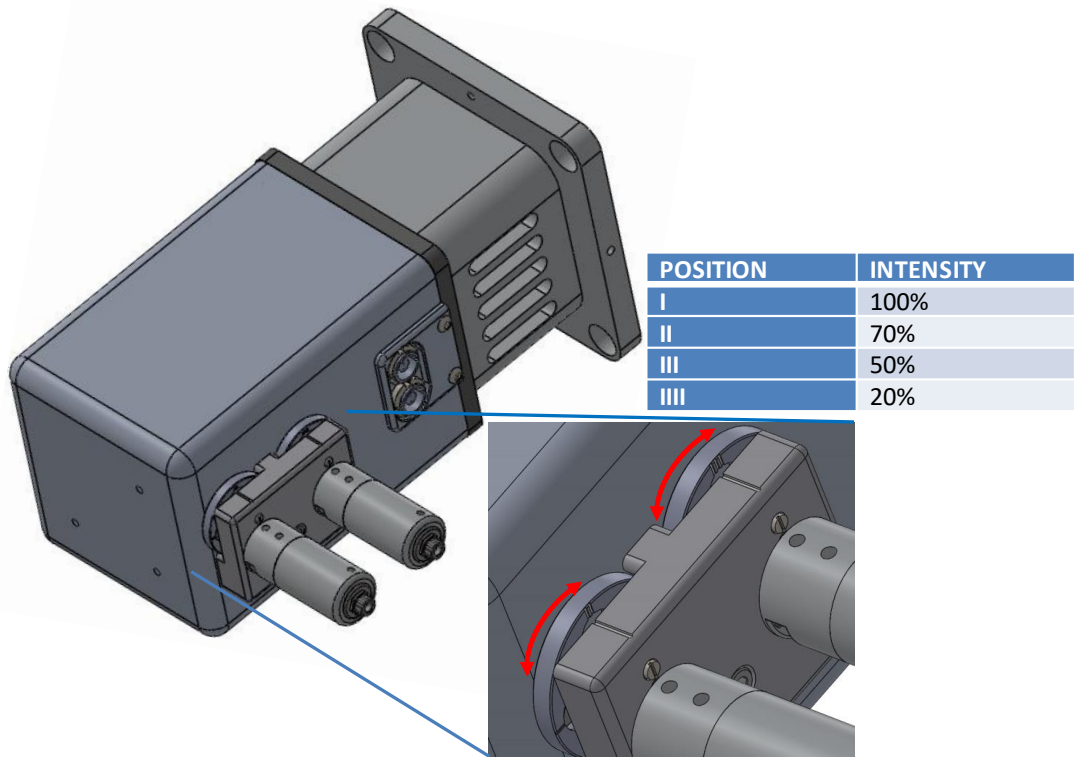


Figure 4-24. MQD-Dual filter wheel selection.

5. If necessary (to avoid detector overload), adjust the iris(es) by rotating the small silver lever around the fiber coupler or filter position by rotating the wheel. This will change the iris diameter/ND filter throughput affecting the amount of light available to enter the spectrometer(s) through the fiber(s).
6. Select 'Cancel Raw Signal Display' (or Press ESC) to exit the screen.

4.6 System Alignment (with Automated Tip/Tilt)

Note: Automated Tip/Tilt alignment is an optional accessory that may or may not have been purchased with your system. If your purchase did not include Automated Tip/Tilt, please see Section 4.5 for System Alignment (with Manual Tip/Tilt).

System alignment is the adjustment of the source and receiver components relative to the variable angle base of the M-2000 system. It is required when the system is first delivered, when first mounting the system onto a base or chamber, or whenever the integrity of the alignment is in question. Figure 4-25

shows the basic components of the M-2000 system, and this naming convention will be followed throughout these instructions.

In the straight-through position (angle = 90°), the white light beam should be centered on both the Receiver Unit aperture and the 4-quadrant alignment detector that is located inside the Receiver Unit. This alignment is easily tested, using the following instructions, which also describes correction to the alignment. All operations will be performed from within the Hardware tab of CompleteEASE.

Note: A System Alignment should only be performed when the instrument is first delivered, after mounting the Light Source and Receiver components onto a base or chamber, or if the integrity of the alignment is in question.

Note: Alignment of the Light Source and Receiver tilt stages on the base should only be adjusted when the base is in the straight-through position. Any adjustment screw should never need to be turned more than ½-1 full turn. If so, it is likely something is not mounted/aligned properly; check previous steps to be sure they were done correctly.

Note: Optional focusing optics must be removed before continuing (if attached).

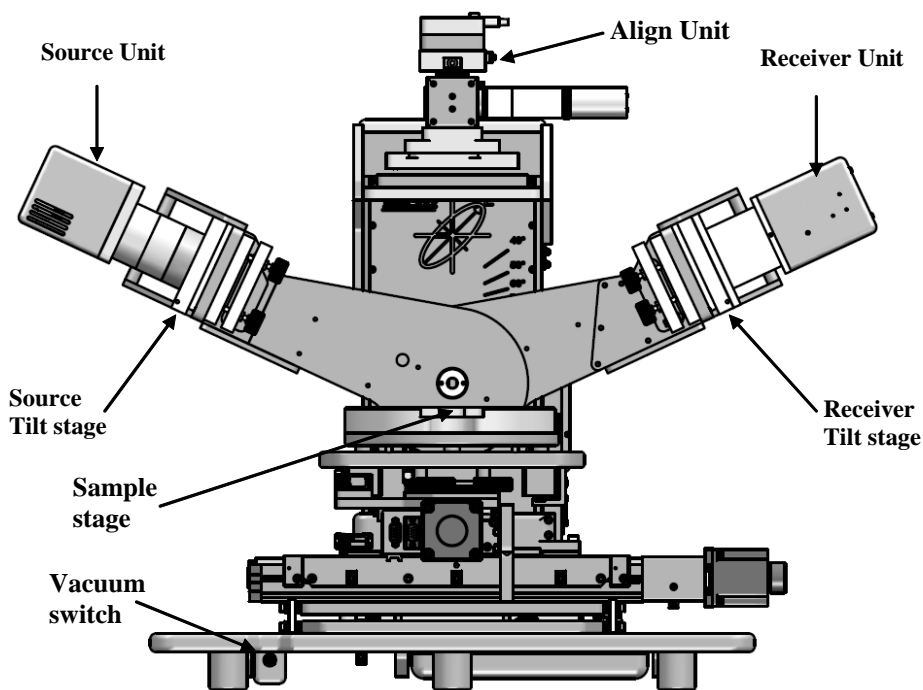


Figure 4-25. Nomenclature.

Source Unit Alignment

The lamp is housed inside the Source Unit, which is mounted to the system with tip-tilt adjustment (Source Tilt Stage) to manipulate the beam direction. The source beam alignment is verified in the straight-through position to ensure that it is aligned on the Receiver Unit aperture.

1. Select **Hardware>Controls>System>'Angle'**. Choose an Angle of 90°. The base will move to the straight-through position.

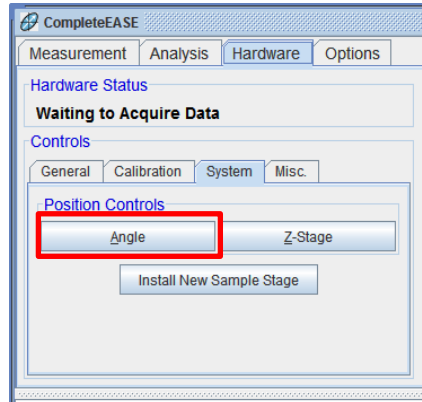


Figure 4-26. Angle button.

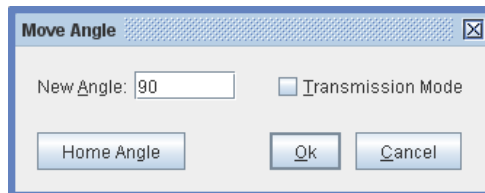


Figure 4-27. Move Angle dialog box.

2. Select **Hardware>Controls>System>'Z-Stage'**. Choose 18mm. This raises the Source and Receiver optics above the Sample Stage, so the beam can be viewed traveling to the Receiver Unit. If in a well-lit room, it may be difficult to view the light beam. Reduce room lights for next step of operation.

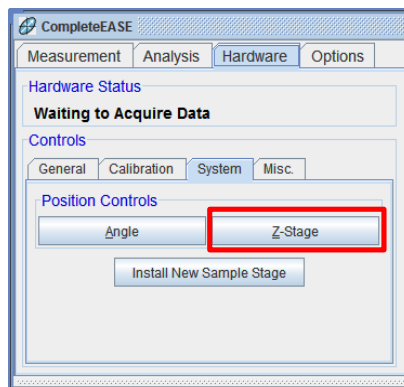


Figure 4-28. Z-Stage button.

3. Move your eye close to the source unit to view along the same path as the beam. This will allow you to see the beam entering the Receiver Unit aperture as shown below.
4. If the beam is not centered, center the probe beam on Receiver Unit aperture by adjusting the Source Tilt Stage using a 3.175mm (1/8") English Allen wrench. When the beam is aligned, there should be a uniform white halo around the aperture (shown below). Misalignment results in a "crescent" halo that is larger on one side of the aperture.

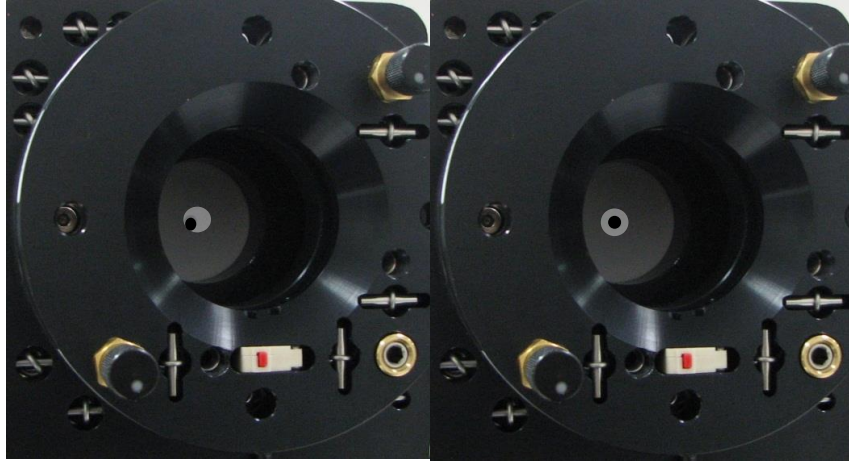


Figure 4-29. Centering the beam on Receiver Unit aperture.

Receiver Unit Alignment

After the Source Unit alignment has been verified, the light beam will be centered on the front aperture of the Receiver Unit. However, this does not ensure alignment through the Receiver Unit. The tip-tilt of the Receiver Unit controls its optical axis and makes sure it is collinear with the beam as it travels through the Receiver Unit. To verify alignment, a 4-quadrant alignment detector is located inside the Receiver Unit. In this section, we will verify alignment and adjust the Receiver Unit to the measurement beam if necessary.

1. Select **Hardware**>**Controls**>**General**>'Align Sample'. The software will ask "Would you like to perform a full sample alignment?" Select 'No'.

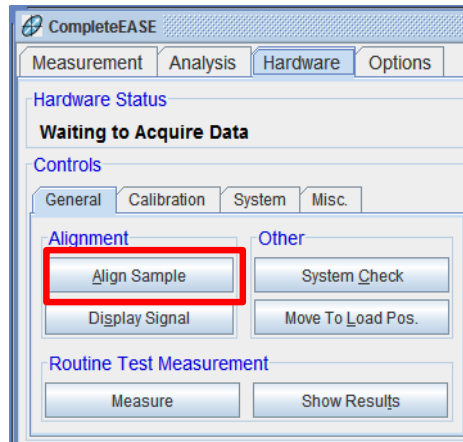


Figure 4-30. Align Sample button.

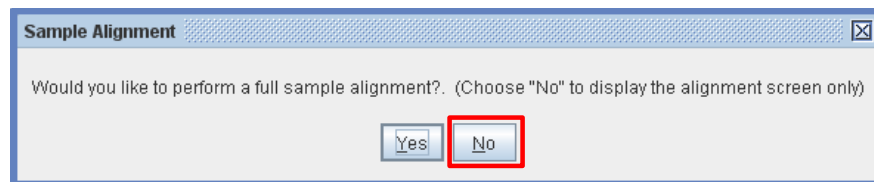


Figure 4-31. Sample Alignment dialog box.

Note: The following alignment screen is a generic screen shot. Refer to the system test report for your specific intensity values.

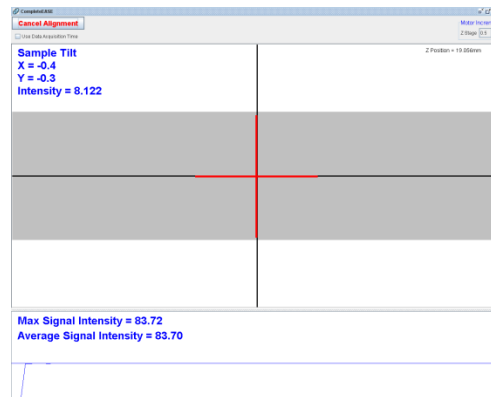


Figure 4-32. Alignment Screen.

2. The alignment screen shows gray areas to represent the intensity reaching each of the 4-quadrants of the detector, with a cross hair to show the position of the light beam inside the Receiver Unit.
 - a. If the Receiver Unit has the optional Internal Alignment Camera, there is no “gray area” but the cross hair positioning is still valid.

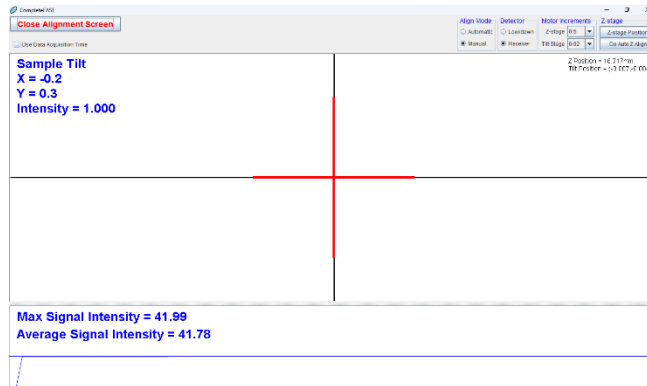


Figure 4-33. Alignment Screen – Receiver Camera.

- b. The Alignment Camera image can be viewed by selecting **Hardware>Controls>Misc>'Additional Hardware Functions'**.

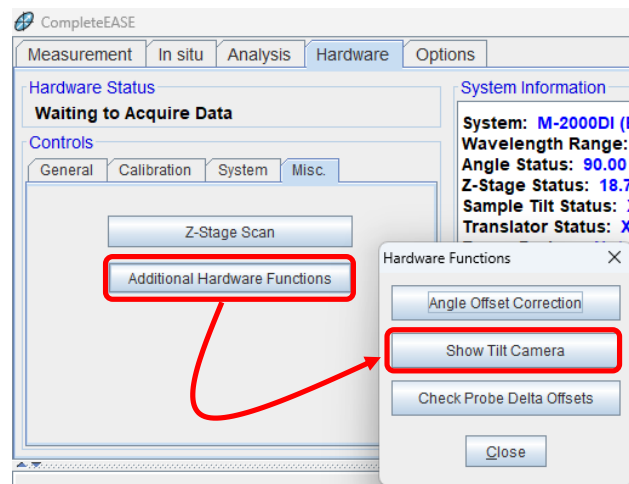


Figure 4-34. Show Tilt Camera button.

3. If the cross hair is not centered, adjust the Receiver Tilt Stage using a 3.175mm (1/8") English Allen wrench until the cross hair is centered on the alignment screen. Now, the beam should be aligned at both the front aperture and throughout the Receiver Unit. If the beam is no longer centered on the receiver aperture, repeat Source Unit and Receiver Unit alignment.
4. Press Escape or click 'Cancel Alignment' when finished.

Verify Signal

Inside the Receiver Unit, the light is directed into a fiber optic cable(s) which carries the light to the Spectrometer(s).

1. View the signal reaching the Spectrometer by selecting **Hardware>Controls>General>'Display Signal'**.

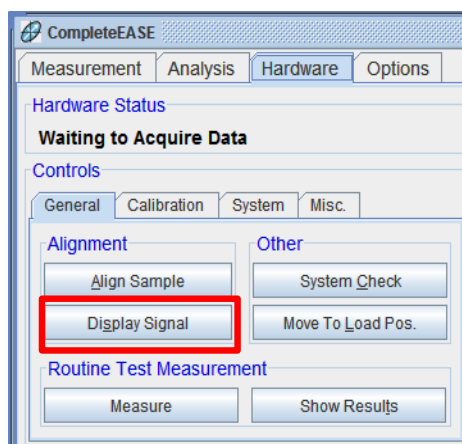


Figure 4-35. Display Signal button.

2. This will display a plot of the magnitude of the signal from all detector channels, as shown in Figure 4-36. The intensities below are typical for an M-2000 in the straight-through configuration.

Note: The following signal screen is a generic screen shot. Refer to the system test report for your specific intensity values.

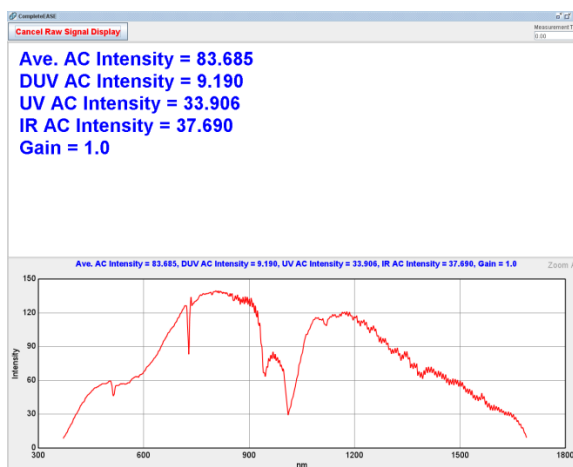


Figure 4-36. Raw Signal Display screen.

3. Check the value of the Gain displayed at the top of the signal intensity screen. In the straight-through position, the gain should be either 1 or 2. Otherwise, the system is not aligned properly or the lamp needs to be replaced and/or aligned. For your specific M-2000 intensity distribution of all channels please refer to the system test report. A hard copy is shipped with each system and a soft copy is included on the backup CD.
4. If part of the UV-VIS signal, optional NIR, or both is "Overloading" as shown in Figure 4-37, the iris(es) or filter position on the Receiver unit may need to be closed down until the signal is no longer "Overloaded" as shown in Figure 4-36. If the system is equipped with the Source ND filter

wheel, this can be adjusted also to avoid the overload (see Neutral Density Filter Wheel section, page 16).

Note: The following signal screen is a generic screen shot. Refer to the system test report for your specific intensity values.

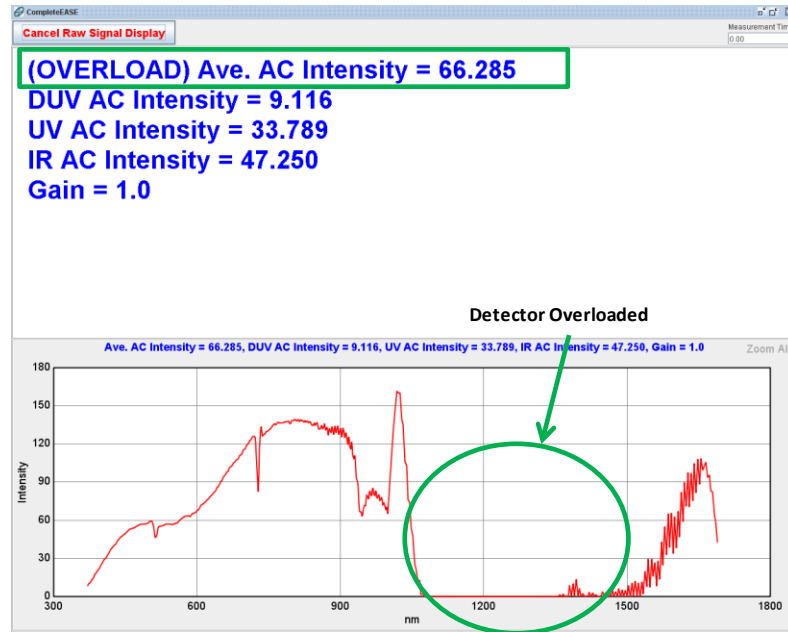


Figure 4-37. Optional NIR spectrometer overloaded on M-2000 system.

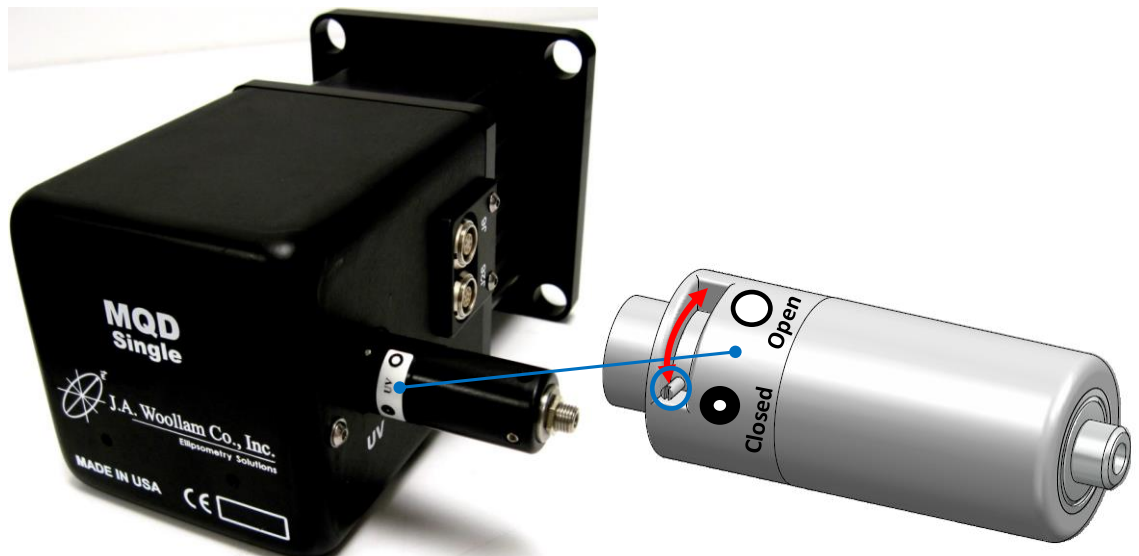


Figure 4-38. MQD-Single iris operation.

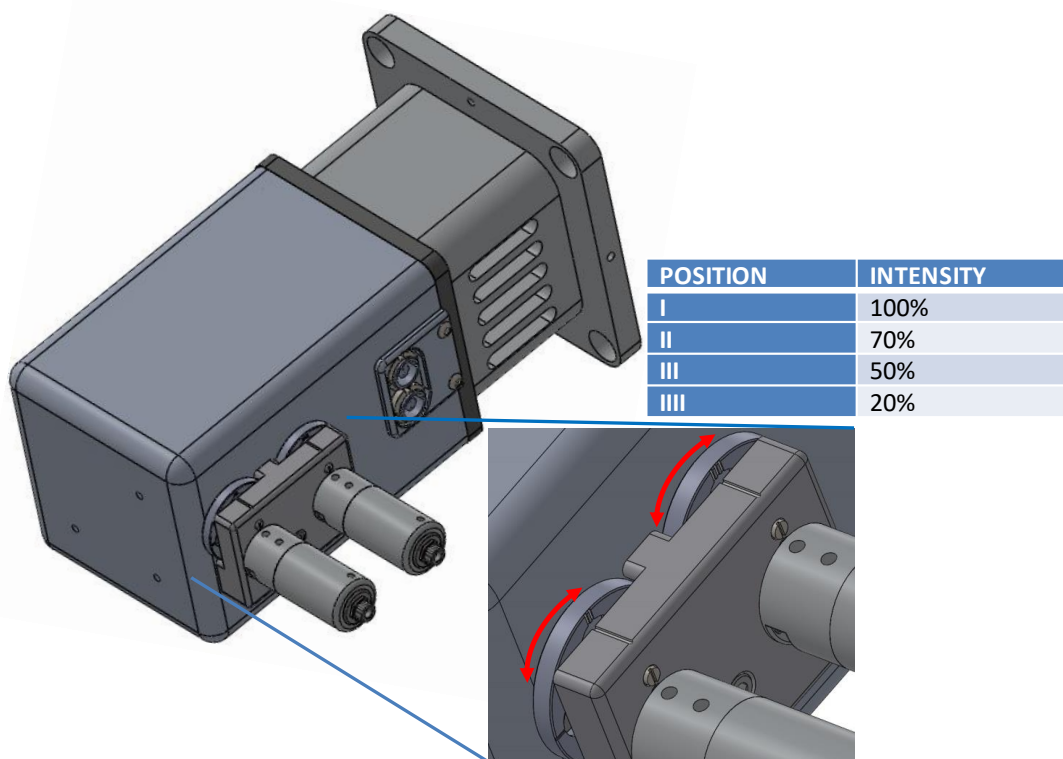


Figure 4-39. MQD-Dual filter wheel selection.

5. If necessary (to avoid detector overload), adjust the iris(es) by rotating the small silver lever around the fiber coupler or filter position by rotating the wheel. This will change the iris diameter/ND filter throughput affecting the amount of light available to enter the spectrometer(s) through the fiber(s).
6. Select 'Cancel Raw Signal Display' (or Press ESC) to exit the screen.

Sample Stage Alignment

Thus far, we have aligned the Source and Receiver Units to the Variable Angle Base. Next, we need to align the Sample Stage to the Measurement Beam. Once we have the sample stage aligned to the system, we will align the Lookdown Detector to the sample stage to allow for automated sample alignment for future samples.

Note: This procedure should only be performed when the system is first installed, if the beam alignment has been adjusted or if the Lookdown detector alignment is under question.

1. Remove any custom mounts or samples and mount the 25nm Oxide on Silicon Calibration Wafer directly to the sample stage. Make sure to switch on the vacuum to hold wafer in place.

2. Select **Hardware>Controls>System>'Z-Stage'** and move to +0.55mm as a starting position for the thickness of the Calibration Wafer.
3. Select **Hardware>Controls>System>'Angle'** and move to 65°.

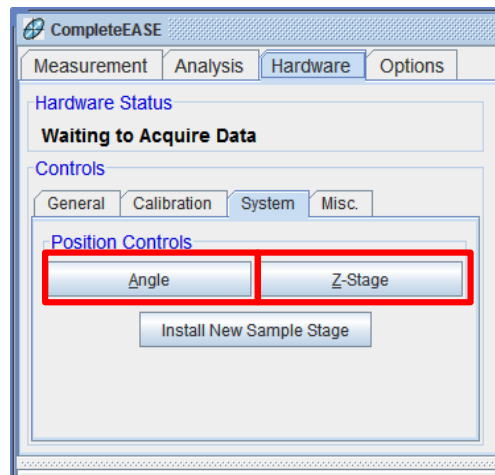


Figure 4-40. **Hardware>Controls>System.**

4. Select **Hardware>Controls>General>'Align Sample'**. The software will ask "Would you like to perform a full sample alignment?" Select 'No'. There are two alignment detectors on this system. In the Alignment Screen, change the Detector to "Receiver".

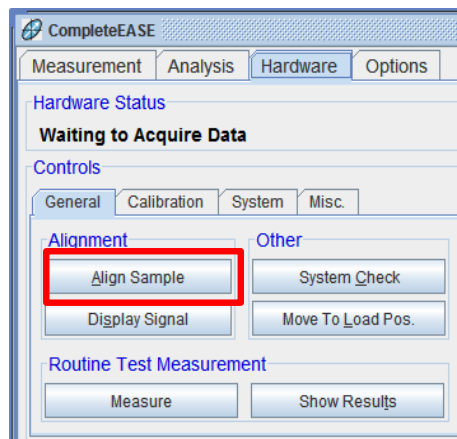


Figure 4-41. **Align Sample button.**

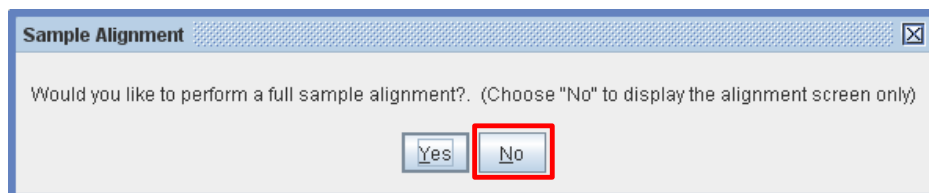


Figure 4-42. **Sample Alignment dialog box.**

Note: The following alignment screen is a generic screen shot. Refer to the system test report for your specific intensity values.

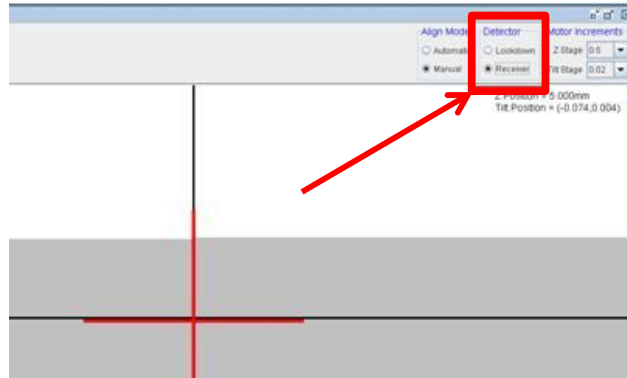


Figure 4-43. Alignment Screen – detector selection.

5. The cross hair will not likely be aligned. We will adjust the sample stage to align the cross hair, effectively matching the Sample Stage to the System Alignment.
6. Align the sample Tip/Tilt by pressing the Up/Down/Left/Right Arrow keys on keyboard. Tip and tilt the sample stage until the cross hair is centered on the screen. You will have to adjust the Tilt Stage Motor Increment to reduce the steps to get “fine” adjustment of the motors.

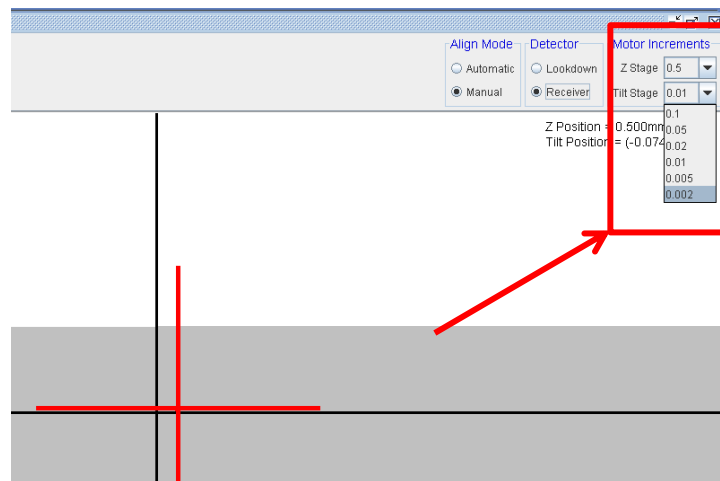


Figure 4-44. Adjusting tilt stage motor increment.

- a. If the Receiver Unit has the Alignment Camera, no gray intensity will appear. If the beam is not entering the Receiver Unit at all, it will display ‘Out of Range.’

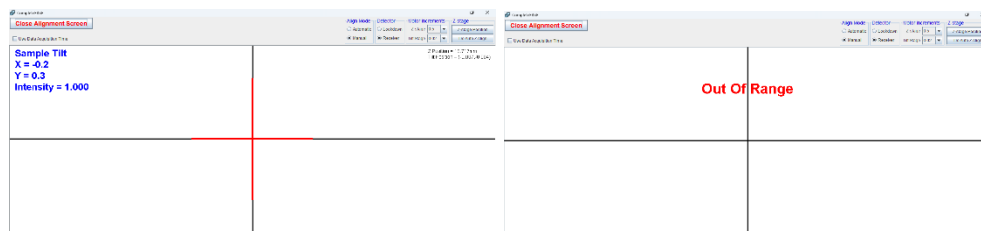


Figure 4-45. Cross hair example – Receiver Camera installed.

7. Align the sample Height. Maximize "Average Signal Intensity" shown across the bottom of the Alignment Screen by adjusting Z-height with PageUp/PageDown keys. Change Z-Stage increment to smaller value and ensure Max Signal is found.

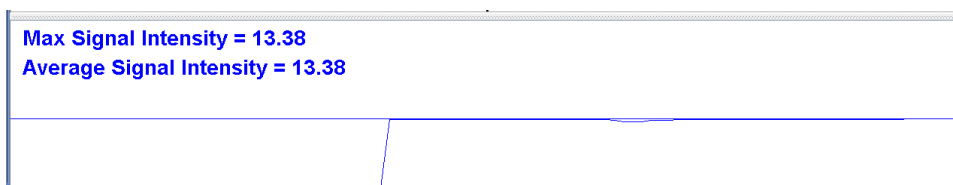


Figure 4-46. Adjusting for Maximum Signal Intensity.

Note: Iterate between the "Tip-Tilt" and "Z" alignments until both are optimized at the same time. When both are optimized simultaneously, the sample stage is aligned to the Measurement Beam.

Lookdown Detector Alignment

After the Sample Stage has been aligned to the measurement beam (previous section), the Lookdown Detector can be aligned to the same sample before it is moved. There are two options for Lookdown Detectors:

- Quad Detector (standard)
- Camera Detector (fast)

Note: It is very important that the sample remains in its aligned condition from the previous section until after this step is completed. The 'Lookdown' Detector is secondary to the 'Receiver' Detector. Therefore, if the sample is removed or the Sample Stage is adjusted, please repeat previous section before proceeding.

Quad Detector Lookdown Alignment

The standard Quad Detector Lookdown is used to perform automated sample tilt alignment. It uses an LED-based optical system to reflect the beam onto the detector at normal incidence to the sample.

1. The Alignment Screen should still be open from the previous section. If not, repeat steps in the previous section (Sample Stage Alignment) to open the Alignment Screen again. In the Alignment Screen, change the Detector to "Lookdown".

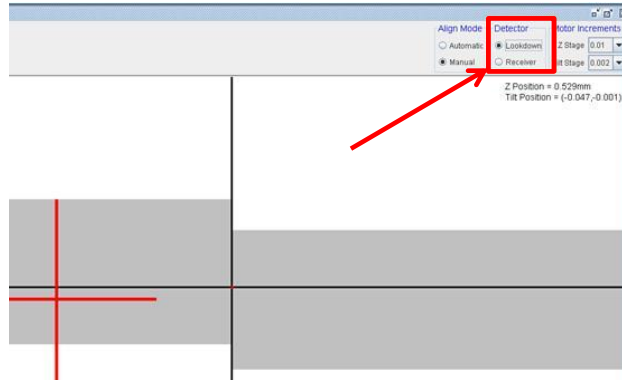


Figure 4-47. Switching Alignment Screen to Lookdown detector.

2. The cross hair may not be centered, which shows that the Lookdown Detector needs to be adjusted to match the Sample Stage (which was just aligned in the previous section). Adjust the Lookdown Detector adjustment screws (see Figure 4-48) on the tilt stage that holds the Lookdown Detector to center cross hair on the screen.

Note: The adjustment screws should never need to be turned more than $\frac{1}{2}$ -1 full turn. If so, it is likely something is not mounted/aligned properly; check previous steps to be sure they were done correctly.

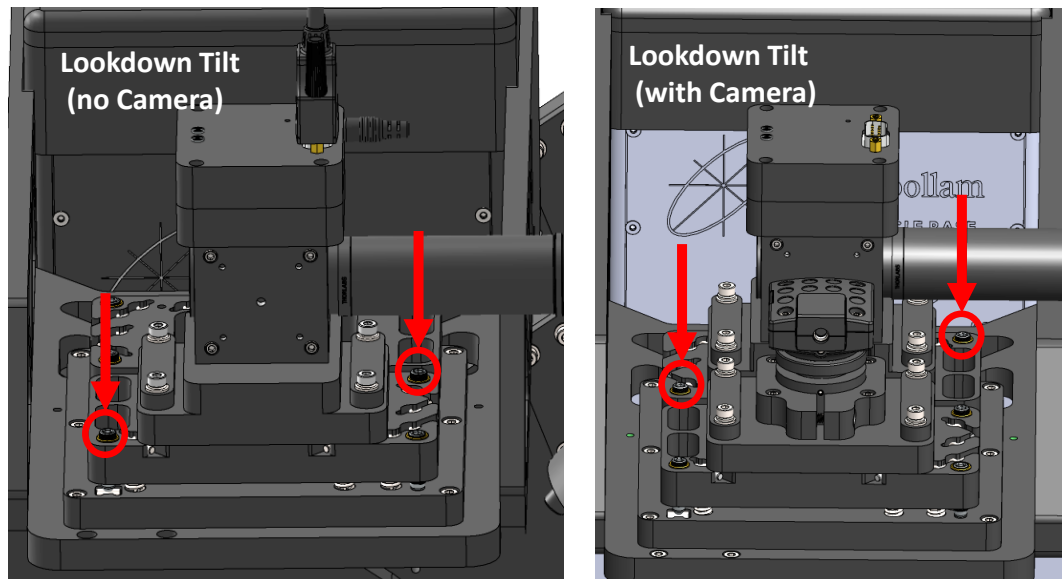


Figure 4-48. Adjusting the Lookdown Detector (Align Unit).

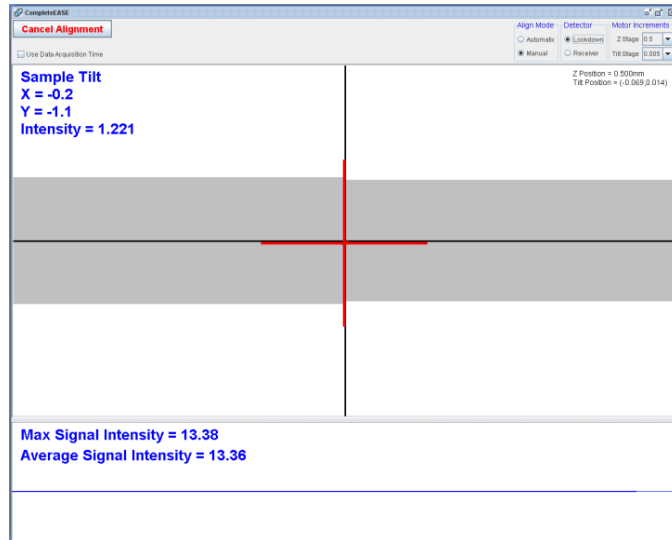


Figure 4-49. Lookdown Detector alignment centered.

3. The Lookdown Detector is now aligned to the system. When samples are mounted, this Lookdown Detector can be trusted to give the correct sample tilt alignment. After this point, all sample measurements will use automated alignment.

Camera Detector Lookdown Alignment

The Camera Lookdown is used for fast automated sample alignment. It is equipped with a Z-Camera, and an optional Tilt-Camera. The Z-Camera is also used as the Imaging Camera to view the sample under measurement.



Figure 4-50. Lookdown Alignment Camera.

1. The reference sample must still be aligned from the previous section. If not, repeat steps in the previous section to verify the sample well aligned on the Receiver Internal Detector.

2. Close the Alignment Screen. Select **Hardware>Controls>Misc>'Additional Hardware Functions'** to open the Hardware Functions window. Select "Show Alignment Camera Setup Dialog". This shows both the Z/Image Camera and the Tilt Camera.

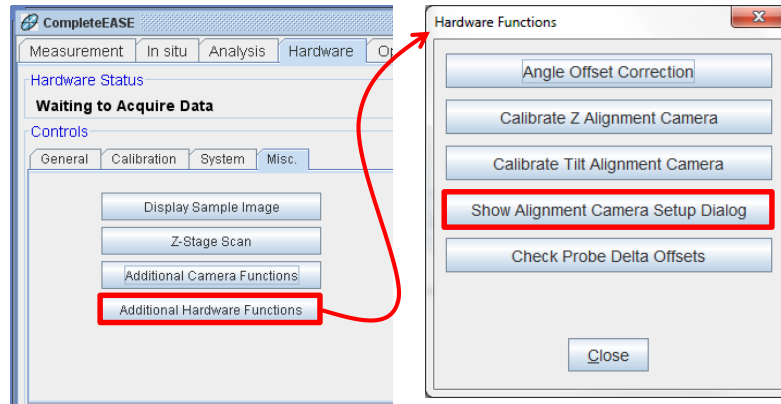


Figure 4-51. Additional Hardware Functions- Show Alignment Camera Setup.

3. Select the 'Z Align' check box to verify the Z LED is working.
4. Select the 'Tilt Align' check box to verify the Tilt LED is working.

Note: For collimated beam (unfocused) measurements, the alignment spot positions do not need to be centered.

5. If both alignment LEDs are ON, the alignment camera will function. Do not make any hardware adjustments, only an offset calibration is needed. If the image is out of focus and this is desired, see Chapter 7 for adjustment instructions.

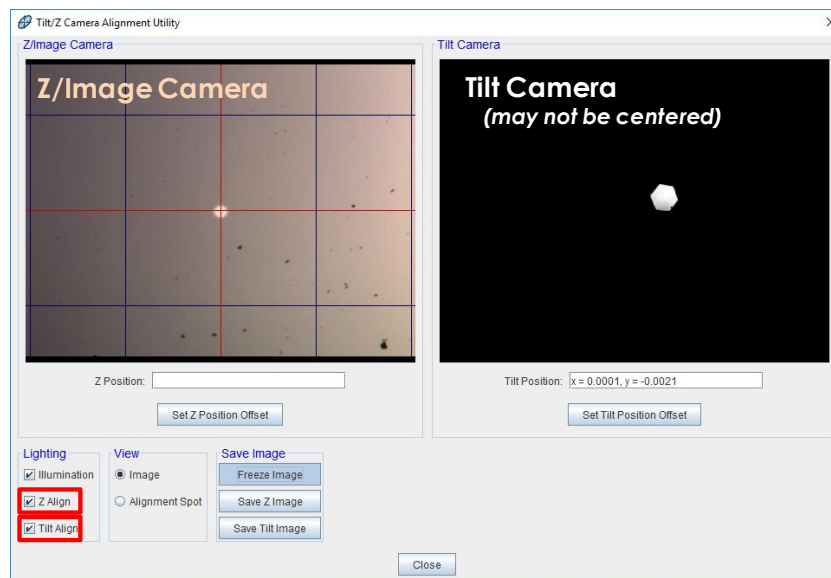


Figure 4-52. Tilt/Z Camera Alignment Utility window.

6. Close the Camera Alignment window. Select **Hardware>Controls>Misc>'Additional Hardware Functions'** to open the Hardware Functions window and calibrate the Camera Alignment Offset(s).
 - a. Calibrate Z Alignment Camera
 - b. Calibrate Tilt Alignment Camera

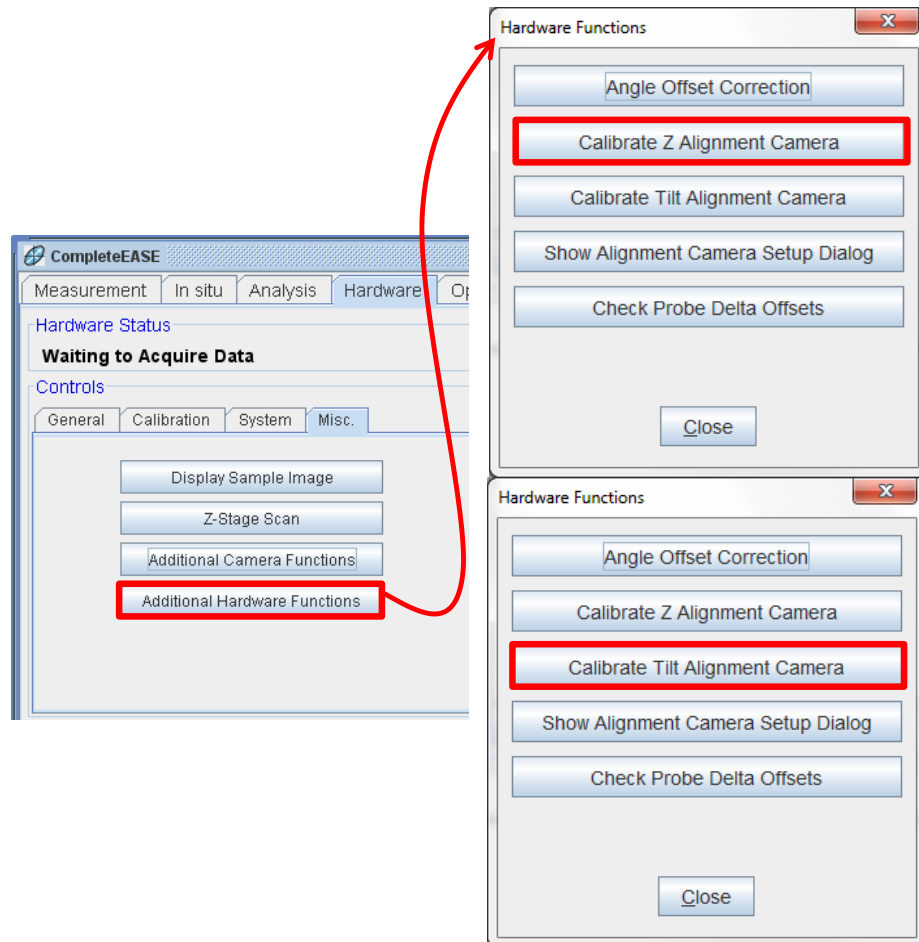


Figure 4-53. Camera Calibration.

7. Select 'Yes' to the message box for each selected calibration.

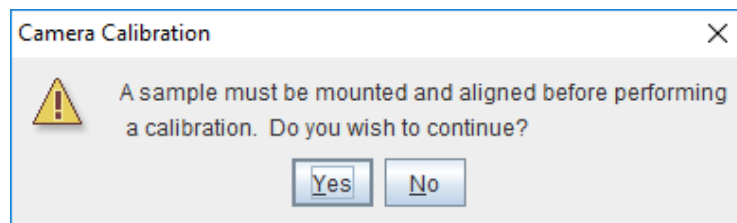


Figure 4-54. Camera Calibration message box.

8. Test the Automated Alignment by performing Sample Alignment, choose "Automatic" Sample Tilt and "Automatic-Camera" Sample Height.

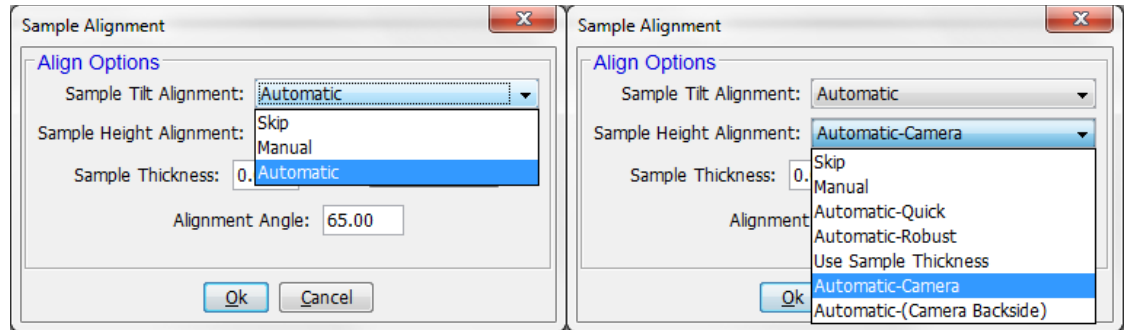


Figure 4-55. Automatic Sample Alignment options.

9. The Camera Detector is now calibrated to the system alignment. When samples are mounted, this Lookdown Detector can be trusted to give the correct sample alignment. After this point, all sample measurements may use automated alignment.

Note: If a manual tilt sample stage (example: Rotator), the Tilt Camera may still be used for sample tilt positioning – cross hair position

4.7 Sample Alignment (with Manual Tip/Tilt)

Note: Automated Tip/Tilt alignment is an optional accessory that may or may not have been purchased with your system. If your purchase included Automated Tip/Tilt, please see Section 4.8 for Sample Alignment (with Automated Tip/Tilt).

Note: This procedure must be performed every time a sample is mounted on the ellipsometer, prior to measurement or calibration.

2. Place the sample on the sample stage.
3. Select **Hardware>Controls>System>'Angle'**. Type 65 in the dialog box and press 'Ok'.

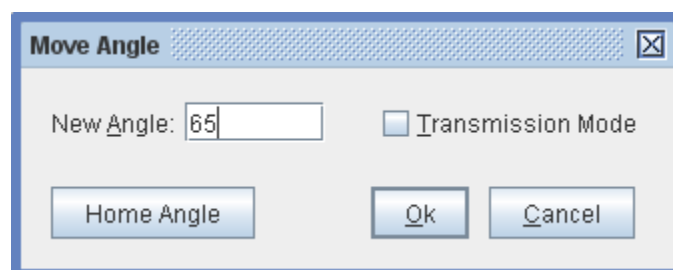


Figure 4-56. Move Angle dialog box.

4. Select **Hardware>Controls>General>'Align Sample'**. When prompted to perform a full system alignment, select 'Yes'.

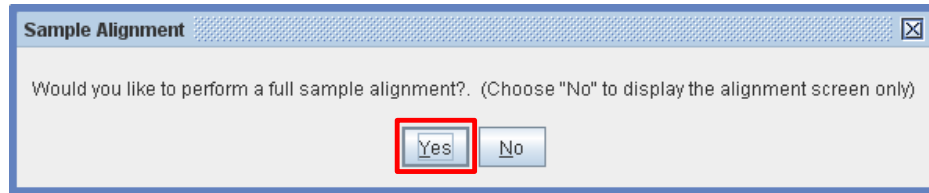


Figure 4-57. Sample Alignment message box.

5. Under the Sample Tilt Alignment drop down menu, select Manual. Under the Sample Height Alignment drop down menu, select Automatic-Quick. Enter the sample thickness into the box. (Cal. Wafer $\approx 0.55\text{mm}$). The Alignment Angle should be 65° . Press 'Ok'.

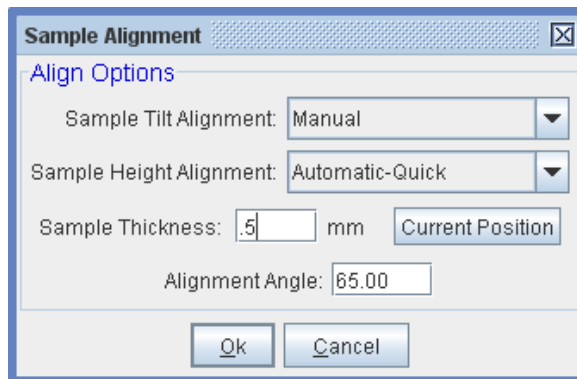


Figure 4-58. Sample Alignment dialog box.

6. Adjust the sample tilt stage knobs until the cross hair is centered.

Note: The following alignment screen is a generic screen shot. Refer to the system test report for your specific intensity values.

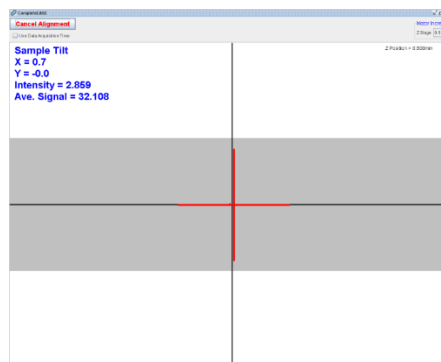


Figure 4-59. Cross hair centered.

- a. If the Receiver Unit has the Alignment Camera, no gray intensity will appear. If the beam is not entering the Receiver Unit at all, it will display 'Out of Range.'

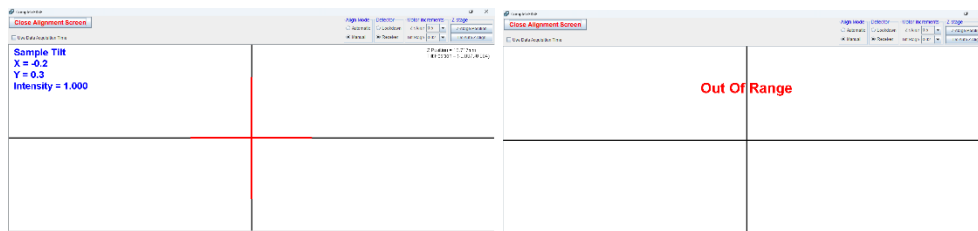


Figure 4-60. Cross hair example – Receiver Camera installed.

7. Select Cancel Alignment (or press ESC) to exit the screen. The system will perform an auto Z height search to find the maximum intensity. If an accurate sample height was entered into Sample Alignment dialog box (see Figure 4-58), the alignment is likely complete. If not, these steps may need to be repeated (iterate tip/tilt and Z height search) until the sample is properly aligned. The software will enforce this action if necessary. Two conditions must be simultaneously met for successful sample alignment:
 - The sample surface must be perpendicular to the plane defined by the optical axes of the source and receiver (sample tip/tilt alignment).
 - The sample surface must be positioned such that the light is reflected into the Receiver Unit aperture (sample height alignment).

4.8 Sample Alignment (with Automated Tip/Tilt)

Note: Automated Tip/Tilt alignment is an optional accessory that may or may not have been purchased with your system. If your purchase did not include Automated Tip/Tilt, please see Section 4.5 System Alignment (with Manual Tip/Tilt).

Note: This procedure must be performed every time a sample is mounted on the ellipsometer, prior to measurement or calibration.

Sample alignment on an auto-angle base with Automated Tip/Tilt alignment is very simple.

1. Place the reference sample supplied with the instrument (~25nm SiO₂ on Si) on the sample stage.
2. Select **Hardware>Controls>General>'Align Sample'**
3. Choose Automatic for Tip/Tilt. If sample thickness is known, enter this value in the Sample Alignment dialog box and select "Automatic-Quick".

If sample thickness is not known, select “Automatic-Robust”. If equipped with the Camera Lookdown, choose “Automatic-Camera.”

4. The ellipsometer will automatically align tip/tilt and Z such that the following two conditions are met (required for successful sample alignment):
 - The sample surface must be perpendicular to the beam from the Lookdown detector (sample tip/tilt alignment).
 - The sample surface must be positioned such that the light is reflected into the Receiver Unit aperture (sample height alignment).

Manual sample alignment options are still accessible for systems with automated tip/tilt stage. Simply select “Manual” when prompted for tip/tilt or Z alignment if desired (i.e. for low-reflecting samples). Use the Up/Down/Left/Right Arrow keys on keyboard to tip and tilt the sample stage in Manual alignment mode. Use the PageUp/PageDown keys to raise and lower the Z stage in Manual alignment mode. Change motor increments in the upper right corner as need to move in smaller or larger steps.

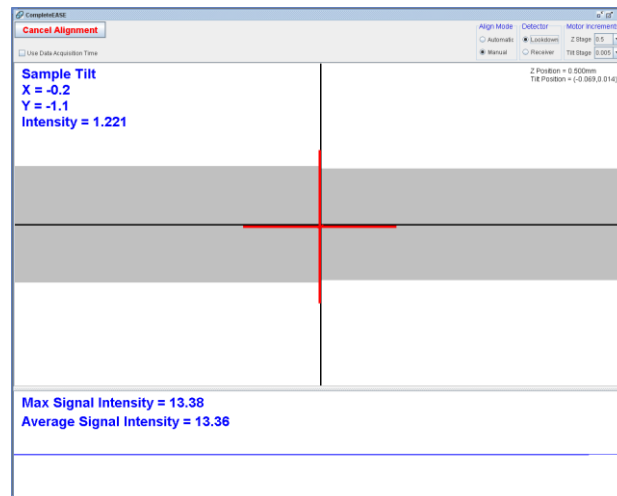


Figure 4-61. Cross hair centered and intensity maximized (beam centered on Receiver aperture).

Note: Follow Section 4.7 Sample Alignment (with Manual Tip/Tilt) procedures when Lookdown detector is disabled.

4.9 System Check (Calibration)

Note: A System Check must be performed the first time the system is operated, or if the source/receiver units have been remounted. The

standard SiO₂ on Si reference sample supplied with the instrument should be used for this procedure.

Note: A System Check should be performed any time the performance of the instrument is in question.

1. Select **Hardware>Controls>General>'System Check'**
2. Click 'Yes' to start the System Check.

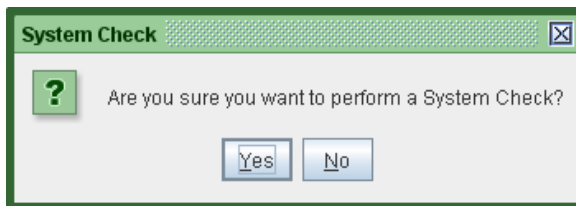


Figure 4-62. System Check message box.

3. When prompted, mount the calibration wafer (~25nm SiO₂ on Si, supplied with the instrument).

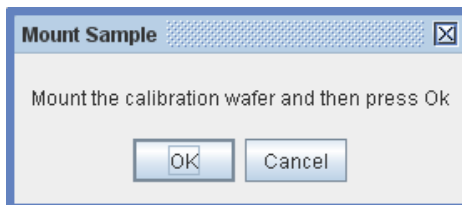


Figure 4-63. Mount Calibration Wafer.

4. CompleteEASE will automatically open the sample alignment screen. Align the sample as described in the Sample Alignment sections above.

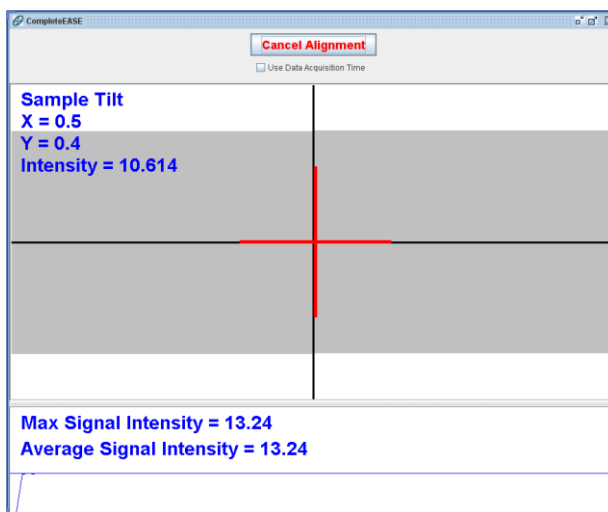


Figure 4-64. Alignment screen.

5. When finished with the alignment, click 'Cancel Alignment' to begin the calibration.
6. System Check status will be displayed in **Hardware>Hardware Status**.

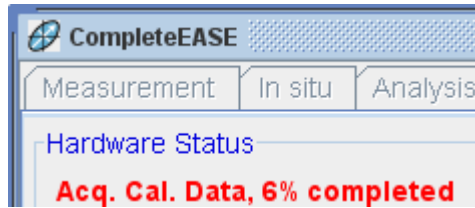


Figure 4-65. Hardware Status.

Evaluating Calibration Results

System Check Successful

If the system check is successful, the following message will appear.

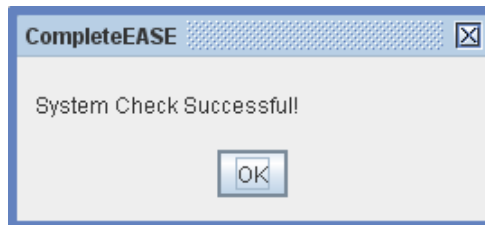


Figure 4-66. System Check successful.

Take a quick look at the spectroscopic data graph to verify that the data fit is good (Figure 4-67). If the model generated Psi and Delta data match the Experimental data, the procedure is finished.

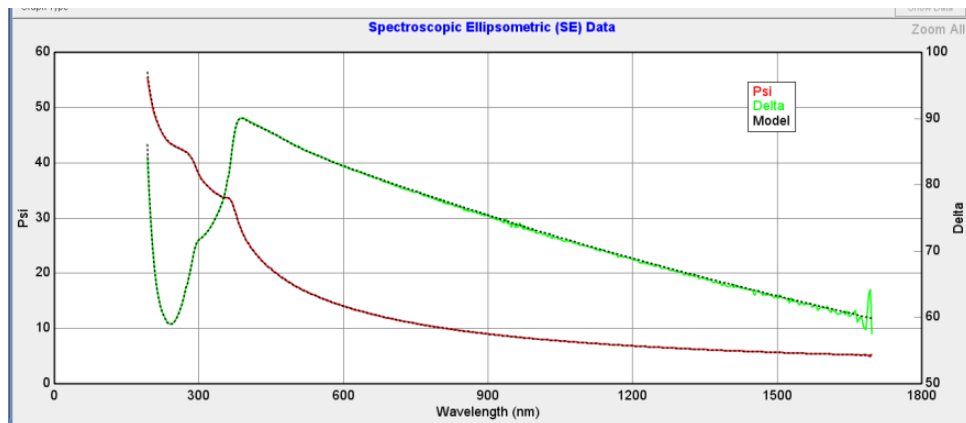


Figure 4-67. A good fit to system check data. It is good practice to verify the system check fit even when the system check is successful.

If the system check is successful, basic testing is finished and the ellipsometer is ready for general use.

System Check Unsuccessful

If the System Check is not successful (that is, the error bars on the determined parameters exceed the acceptance limits), a message box describing the error will be displayed.



Figure 4-68. System Check error.


To view the calibration parameters, select **Hardware>System Information>'View Hardware Log'**

In most circumstances, the error bars on the Ps (polarizer), Cs (compensator), and As (analyzer) azimuthal calibration parameters all should be less than $\pm 0.01^\circ$. If the system check is not successful, check the following:

- The system is aligned and the light intensity is adequate.
- If the intensity is greater than 40, try reducing the intensity by half and calibrating again. This will prevent the detector from being overloaded with light at certain analyzer positions during calibration.
- Read Chapter 11 Performance Checks and/or Chapter 12 Troubleshooting for possible problems and solutions. If a successful system check still cannot be performed, contact the J.A. Woollam Co. for assistance.

Note: The SiO₂ thickness varies significantly from wafer to wafer (20-30nm). 25nm is the nominal thickness. Your wafer may have SiO₂ thicker or thinner than 25nm.

4.10 Instrument Shutdown

1. Save any necessary data and/or model files.
2. Select (L[⏏]) Exit button  in upper right-hand corner of program screen.
3. Exit Windows.
4. Turn off the Computer, Monitor, EC box and the Lamp Power Supply Module (M-2000 box). There is no particular order for the turning off system components.

5 Data Acquisition

5.1 Acquiring Ellipsometric Data

Once the Performance Check is successfully completed, the instrument is ready to collect data.

Note: This section is generic. Options vary based on System Configuration.

1. Place sample on the sample stage.
2. Select <Prompt for Acquisition Parameters> from **Measurement>Measurement Controls>Recipe:**

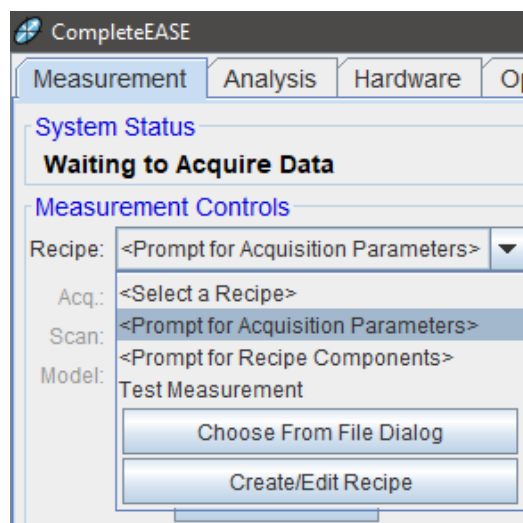


Figure 5-1. Prompt for Acquisition Parameters.

3. Choose 'Measure'.
4. If 'Save Data after Measurement' was checked, the Save Data window appears. Navigate to desired folder, give a filename and comment (optional), and then choose 'Save'.

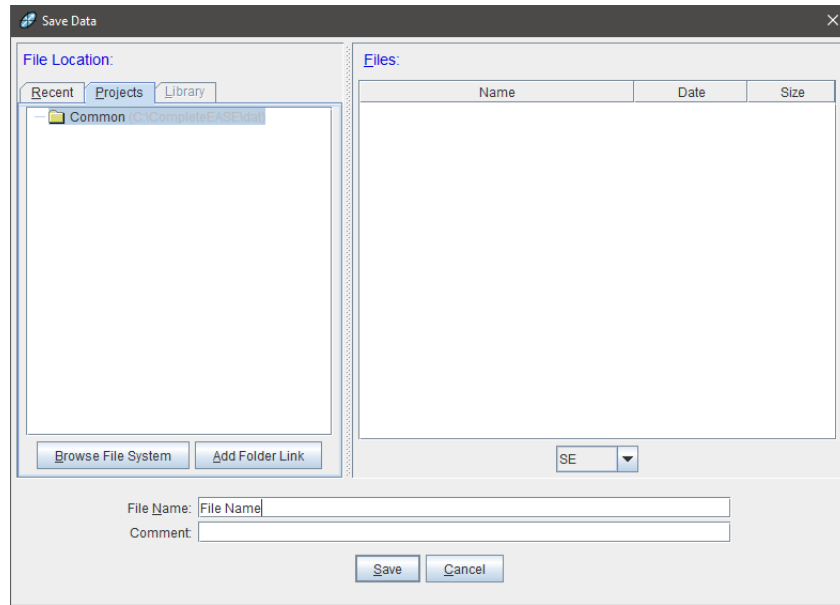


Figure 5-2. Save Data navigation box.

5. The Acquisition Parameters Setup window will appear next.

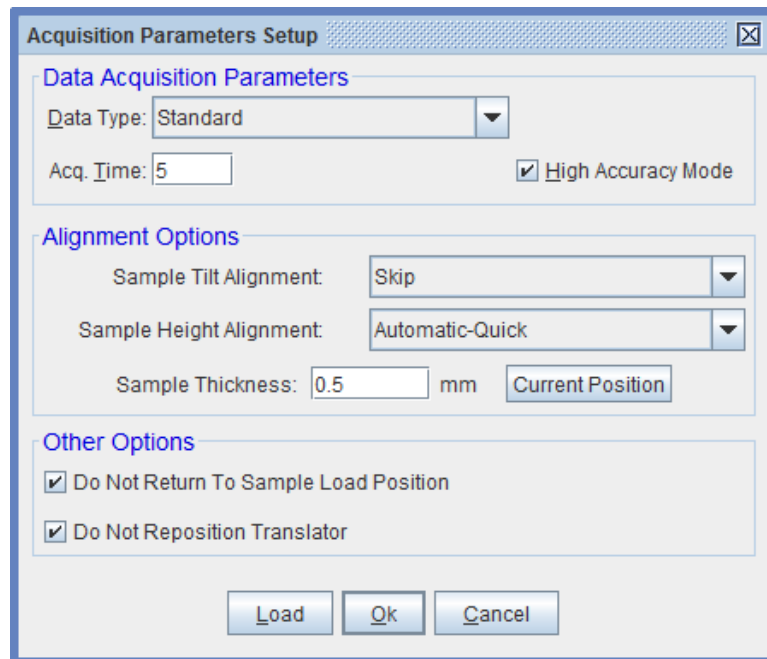


Figure 5-3. Acquisition Parameters Setup window.

6. Under **Data Acquisition Parameters**, select 'Data Type' and enter 'Acq. Time' (in seconds). With High Accuracy Mode checked, data is collected with input polarizer set to +45° and -45° and averaged. This improves data accuracy and is recommended for most applications.
7. Under **Alignment Options**, there are multiple selections.

- For Sample Tilt Alignment: choose 'Skip', 'Manual', or 'Automatic' Automatic option only available for systems with automated tip/tilt stage.
- For Sample Height Alignment: choose an option:

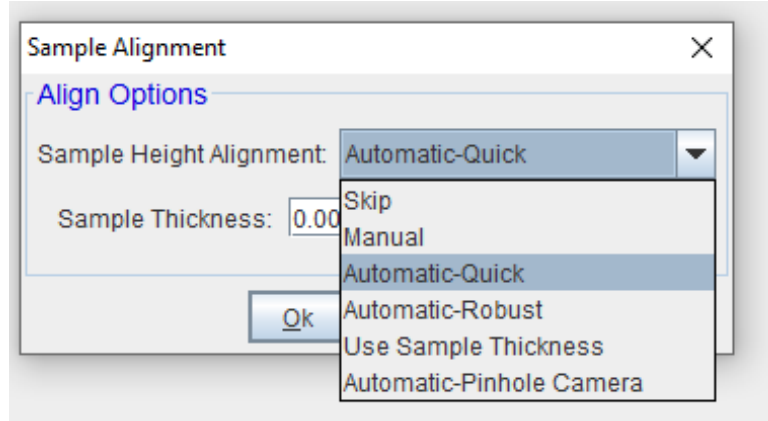


Figure 5-4. Sample Height Alignment options.

- A “Quick” sample height alignment searches a narrow Z range around the Z-height entered in the Sample Thickness box. This option is recommended (to save time) if mapping or many measurements will be made. Click ‘Set to Current Position’ to enter current Z-position into the Sample Thickness box – useful if a sample with similar thickness was last aligned.
 - A “Robust” sample height alignment searches the full Z range of the base. This option is recommended if sample thickness is not known, if the sample was not previously aligned, or if a sample with similar thickness was not last aligned.
 - The “Pinhole Camera” option is the fastest alignment and works well if the offset correction is valid.
 - ‘Skip’ may be checked if the sample alignment has already been completed. This is not recommended if the current sample has not yet been aligned.
8. When finished, click ‘Ok’ to start the measurement sequence. The Align Sample window appears (unless ‘Skip’ was selected for both tilt and Z alignment). If manual alignment options were selected, perform the alignment and click ‘Cancel Alignment’ when finished to close the alignment screen. If automatic alignment options were selected, the software will automatically perform the sample alignment and no action is necessary. Ellipsometric data acquisition will start after the sample alignment selections are executed.
 9. **System Status** will show measurement progress.



Figure 5-5. System Status during data acquisition.

10. When the measurement is complete, the **System Status** will revert back to 'Waiting to Acquire Data', and data will be displayed in the graph.

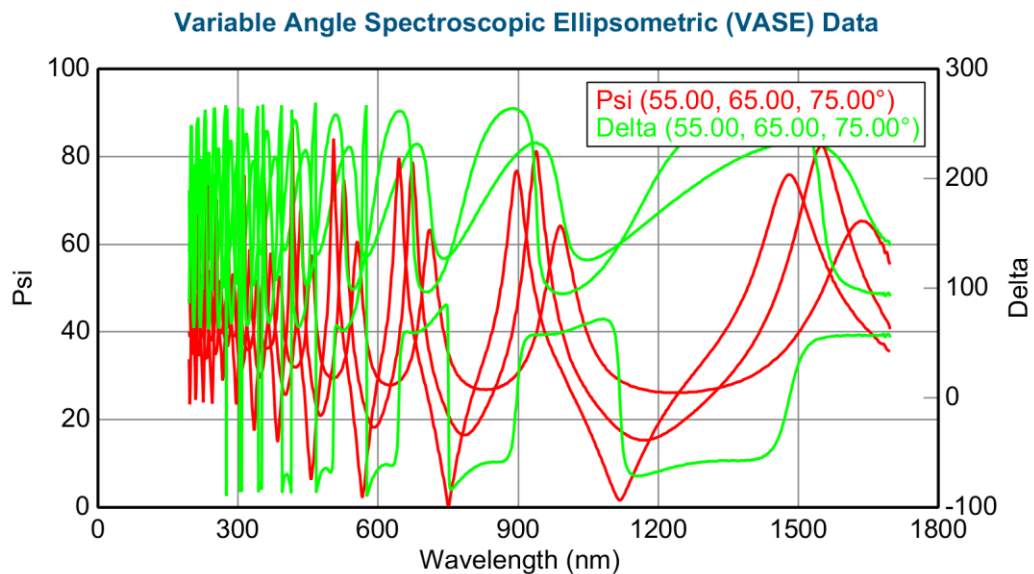


Figure 5-6. Example data after measurement.

11. Analyze data using procedures described in the CompleteEASE Data Analysis manual.

5.2 Recipes

Data acquisition and analysis can be completed in one step by using a Recipe. A Recipe combines Data Acquisition Parameters and an Analysis Model, allowing data to be analyzed simultaneously with measurement.

Use of a Recipe requires that Data Acquisition Parameters and an Analysis Model have been saved previously. An example drop-down list containing multiple Recipes is shown below.

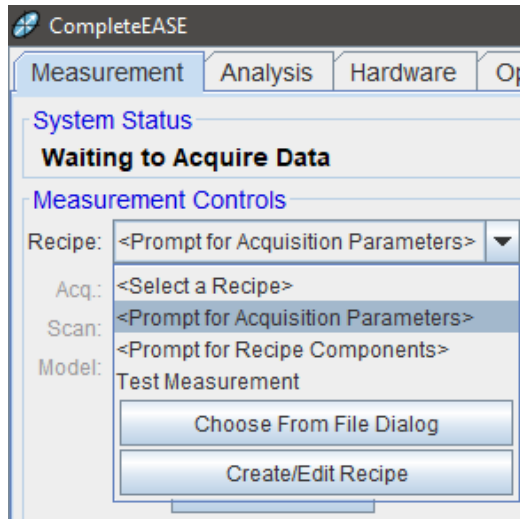


Figure 5-7. Recipe selection.

Prompt for Recipe Components

To measure samples using previously saved Acquisition Parameters and Analysis Model, select <Prompt for Recipe Components>. The **Measurement Controls** panel will update to reflect <Prompt At Measurement Time> for Acq., Scan, and Model. Click 'Measure' to open the Choose Recipe Components dialog box.

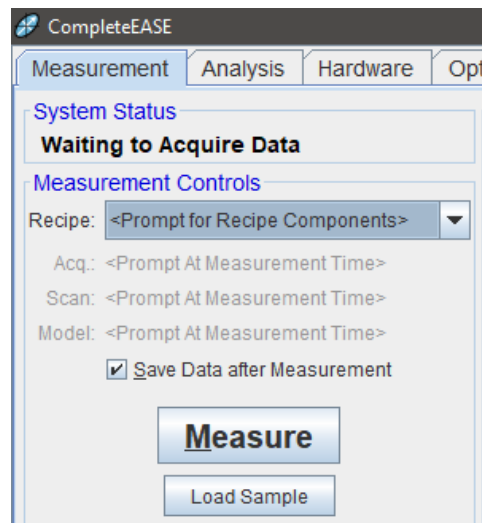


Figure 5-8. <Prompt for Recipe Components>.

Choose desired Acq. Parms and Model and click 'Ok' to start the measurement. (The Scan Pattern option in the figure below is available only for systems with optional sample translation.)

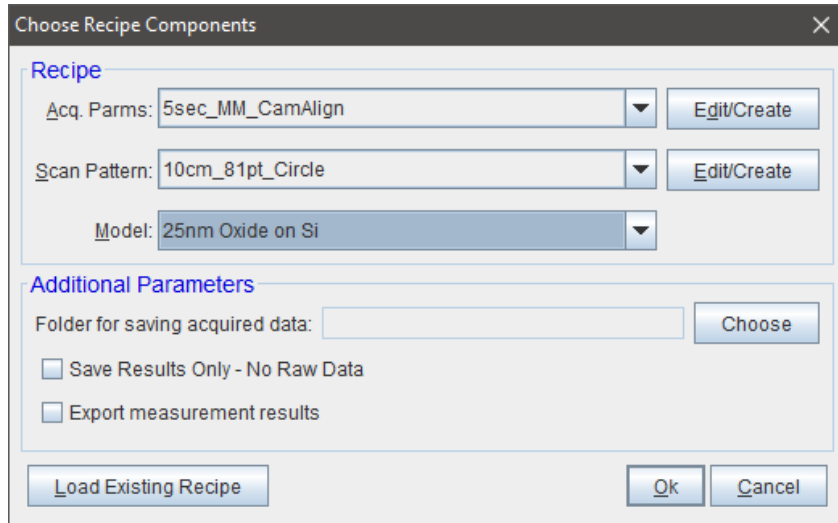


Figure 5-9. Choose Recipe Components.

Creating New Recipes

The instrument may have been supplied with a few default Recipes for use with the calibration wafer, but customized Recipes will be required for specific sample types.

To create a new Recipe using previously saved Acquisition Parameters and Analysis Model, select “Create/Edit Recipe” (shown in Figure 5-7) to open the Create/Edit Recipe dialog box. Choose desired Acq. Params and Model and click ‘Save Recipe’ when finished. (The Scan Pattern option in the figure below is available only for systems with optional sample translation.)

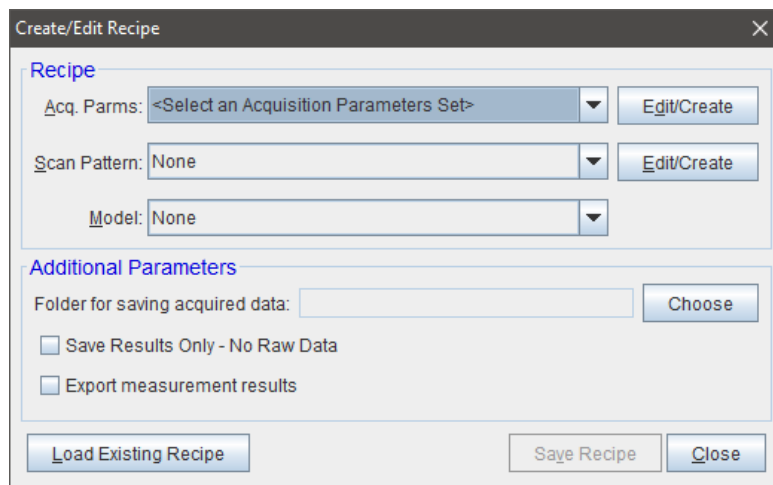


Figure 5-10. Create/Edit Recipe.

Creating New Acquisition Parameters

To create new Acquisition Parameters, select “Create/Edit Recipe” (shown in Figure 5-7), then “Edit/Create” next to each recipe component in the [Recipe](#) panel to open the setup window.

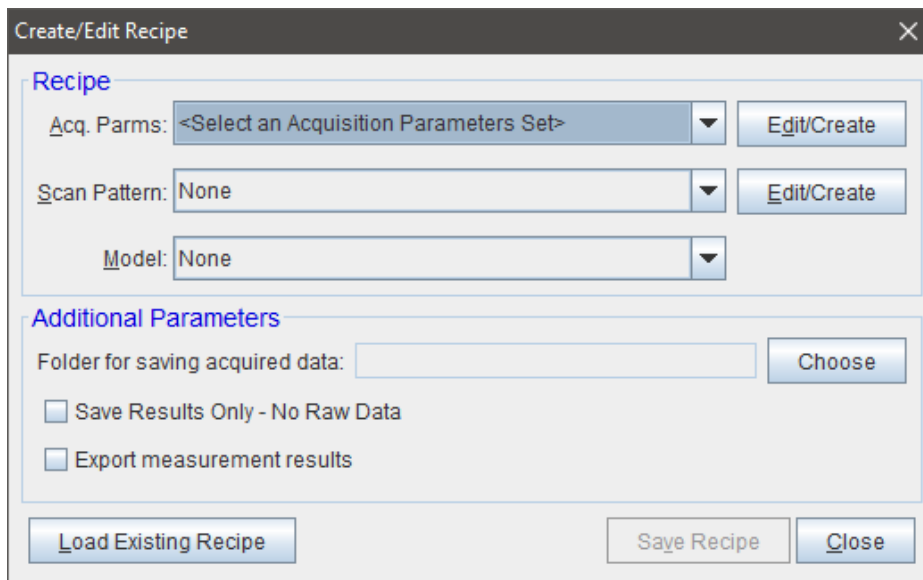


Figure 5-11. Edit/Create Recipe.

Use the ‘Save’ button near the bottom of the screen after entering desired measurement parameters. Saved Acquisition Parameters will now be available for <Prompt for Recipe Components> or creating a new Recipe.

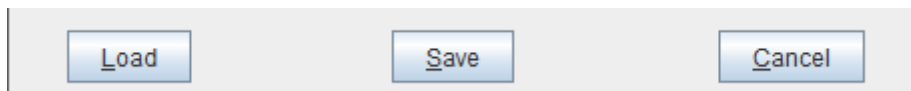


Figure 5-12. Save Parameters (example).

Creating New Analysis Models

This is discussed in detail in the CompleteEASE Data Analysis Manual. View the CompleteEASE Data Analysis Manual by selecting:

Options>Miscellaneous>‘Show Manual’ (or Press F1)

Using a Recipe

1. To measure and analyze a sample using a Recipe, select the desired Recipe from: **Measurement>Measurement Controls>Recipe:**

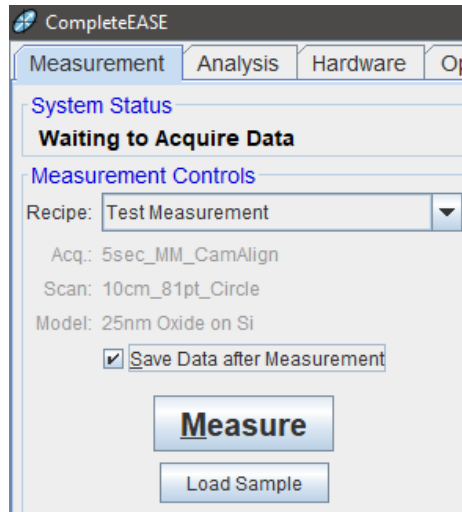


Figure 5-13. Example Recipe.

2. After Recipe is selected, simply click 'Measure'. The measurement sequence will proceed normally, starting with sample alignment (unless 'Skip' is selected in the Data Acquisition Parameters).
3. After the measurement is completed, the data will be analyzed using the Model contained in the Recipe. Notice that Model fit results are now displayed in **Measurement>Fit Results** panel.

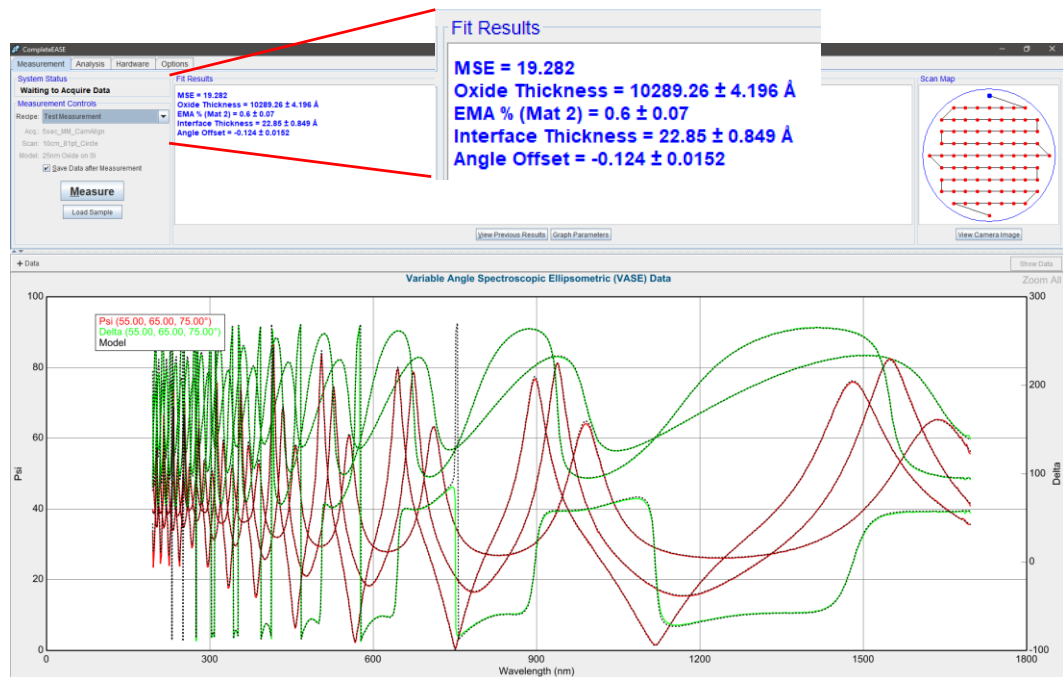


Figure 5-14. Example data after measurement with Recipe.

4. To view the Model used, switch to the **Analysis** tab. Note that the **Analysis>Data** panel indicates the data filename given, or if the data has not yet been saved.

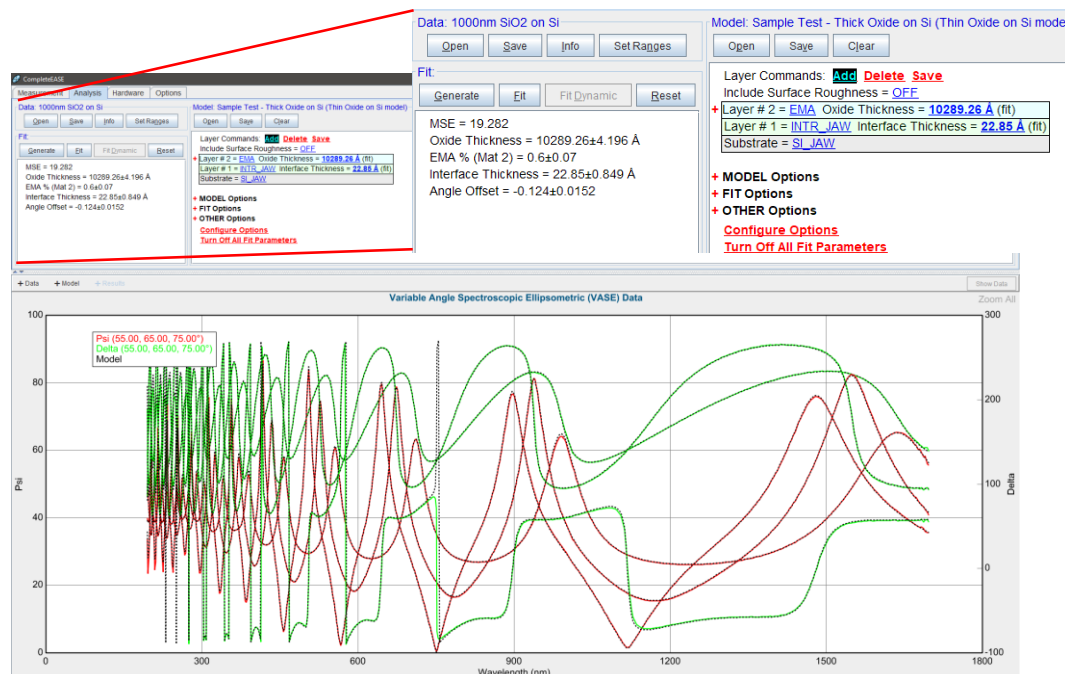


Figure 5-15. Example data after measurement with Recipe – Analysis tab.

5.3 Data Types

Most applications will require only the Standard Data Type. However, some applications benefit from or require Generalized Ellipsometry, Mueller Matrix, or Reflection Intensity. Data Acquisition for each Data Type is briefly discussed here.

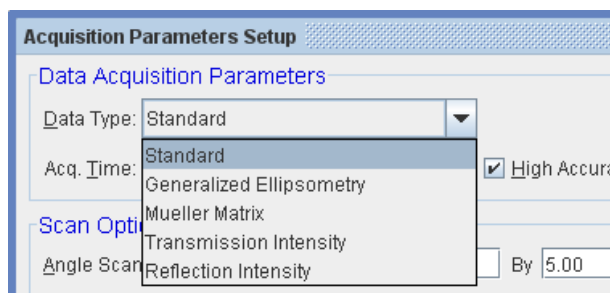


Figure 5-16. Data Types.

To view Acquisition Parameters, select “Create/Edit Recipe” (shown in Figure 5-7), then “Edit/Create” next to Acq. Params in the **Recipe** panel to open the Acquisition Parameters Setup window.

Standard

The Standard Data Type is used for most applications. This data type acquires Ellipsometric Psi and Delta data, as well as reflectance and depolarization data.

Note: Reflectance data is most accurate using the Reflected Intensity Data Type, described below. Selecting Reflected Intensity Data Type allows baseline measurement from reference sample.

Note: Depolarization data is most accurate after performing a DC Offset calculation. To perform, click on **Hardware>Controls>Calibration>'DC Offset'**. The software can be configured to automatically perform DC offset after a specified time period in the “Hardware Configuration” file.

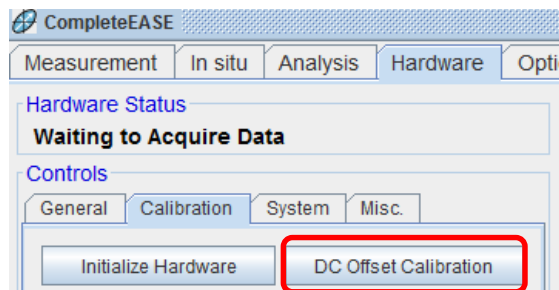


Figure 5-17. DC Offset correction.

Mueller Matrix

Mueller Matrix data is required for complicated samples with both anisotropy and depolarization. The M-2000 measures 11 Mueller Matrix elements.

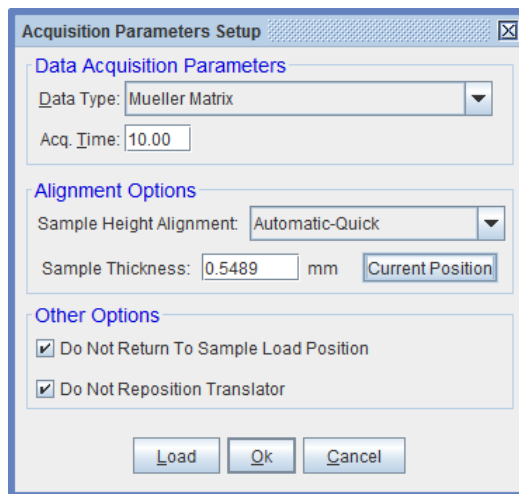


Figure 5-18. Mueller Matrix data acquisition.

After measurement, data are displayed. To view Mueller Matrix elements, select the Graph '+Data' button, and select one of the Mueller Matrix Data options.

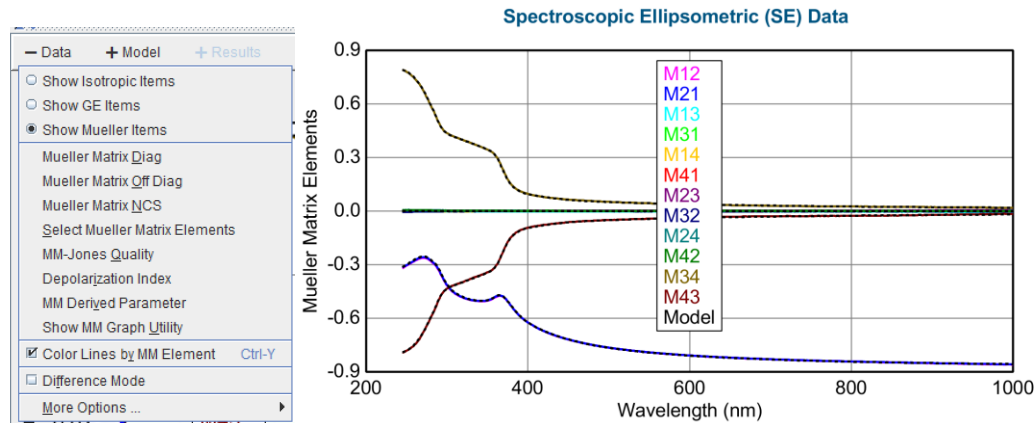


Figure 5-19. Mueller Matrix data.

To view specific Mueller Matrix elements, choose 'Select Mueller Matrix Elements', and a new window will appear allowing the user to specify which elements to display.

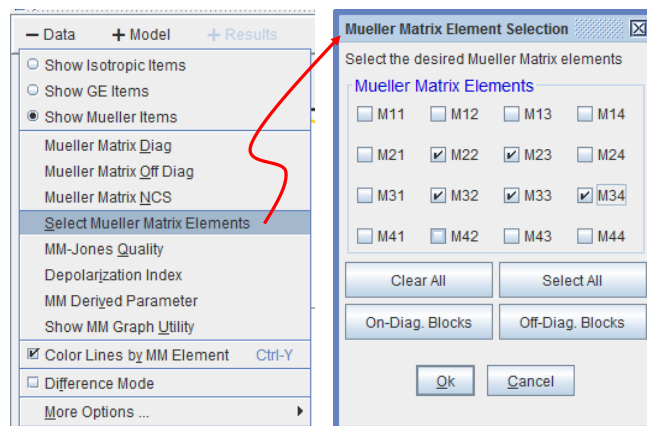


Figure 5-20. Mueller Matrix Element Selection window.

Reflection Intensity

This Data Type measures the reflected intensity of the light beam. Baseline intensity is measured from a reference sample (thermal oxide on silicon).

Note: Reflection Intensity is also measured with "Standard" Data Type, but no baseline is used. Reflection Intensity Data Type is recommended for best accuracy.

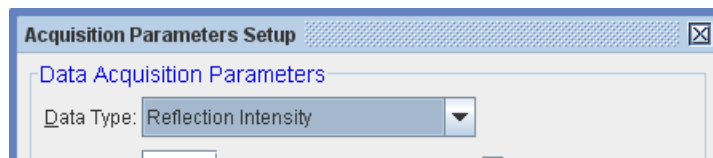


Figure 5-21. Reflection Intensity data acquisition.

When the measurement is started, the user will be prompted to mount the reference sample. The default is 25nm SiO₂/Si, but can be changed using the System Check Model setting.

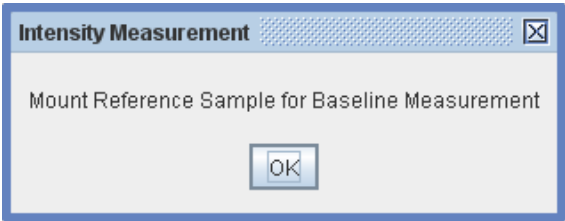


Figure 5-22. Mount reference sample for baseline reflectance measurement.

Align the reference sample. The system will then acquire a baseline measurement from the reference sample.

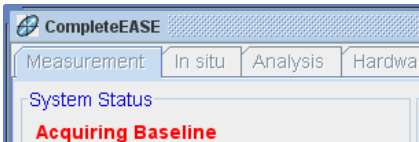


Figure 5-23. System Status – acquiring baseline.

When the baseline measurement is completed, follow the prompts to mount and align the sample of interest.

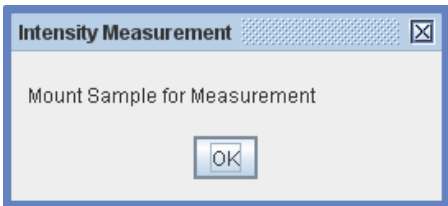


Figure 5-24. Mount sample for reflectance measurement.

After the measurement, Psi and Delta data are initially displayed in the Graph. To view Reflection Intensity data, select the '+Data' Graph button and choose "Intensity" from the Isotropic Items.

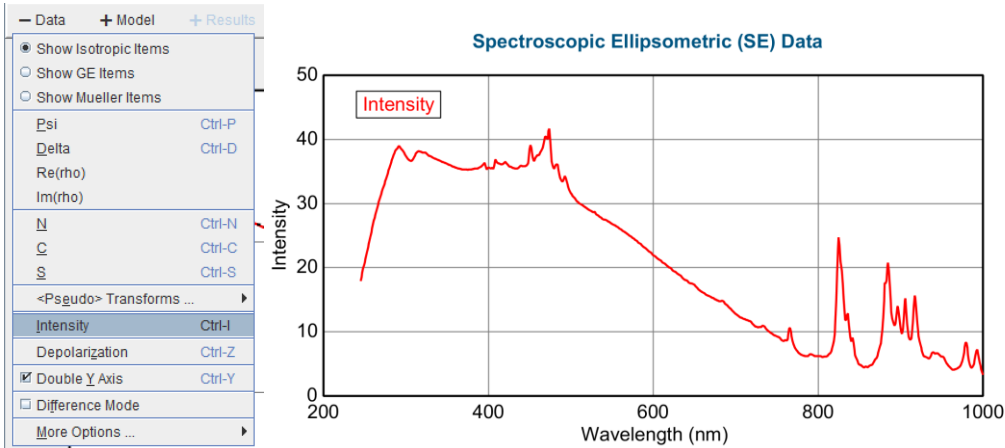


Figure 5-25. Intensity graph selection.

5.4 Routine Test Measurements

The Routine Test Measurement feature in CompleteEASE is useful for keeping track of system performance over time. This feature can be accessed from the **Hardware** tab (see Figure 5-26). There is an initial setup procedure required to use this feature which is described in the Initial Setup section below. For this feature to be useful it is important to always use the same sample for the measurements.

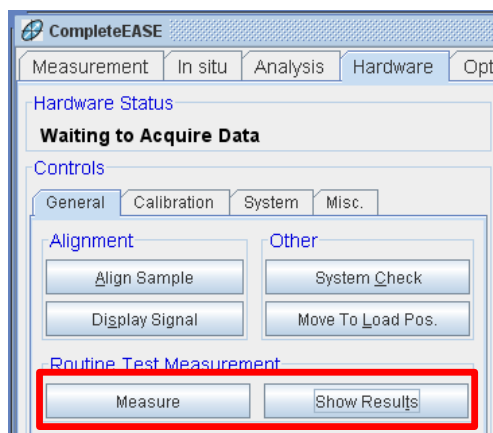


Figure 5-26. Routine Test Measurement in the Hardware tab.

Initial Setup

This may be done at the factory, but can be changed for a specific application.

1. Create a Recipe for the sample to be used for the Routine Test Measurement.
2. Create a folder called "Routine Test Measurement" in the \CompleteEASE\Recipe folder and copy the ".recipe" and ".parms" files created in step 1 into this folder. The model created in step 1 should be placed in the \CompleteEASE\Mod folder or one of its sub folders.
3. From the **Hardware** tab, choose 'Edit Hardware Config.' to bring up the "Hardware Configuration" dialog box. Check the box labeled "Show Advanced Config. Options" and then expand the "Routine Test Measurements" section in the list on the left (see Figure 5-27). Select the "Recipe=" item and type the name of the recipe in the "Edit: Recipe" field at the top right. If you would like the software to prompt the user to perform the test measurement at periodic intervals, set the "Measurement Period" parameter to a value greater than 0. For example, if the "Measurement Period" is set to "1" then the software will prompt the user to perform a test measurement once per day.

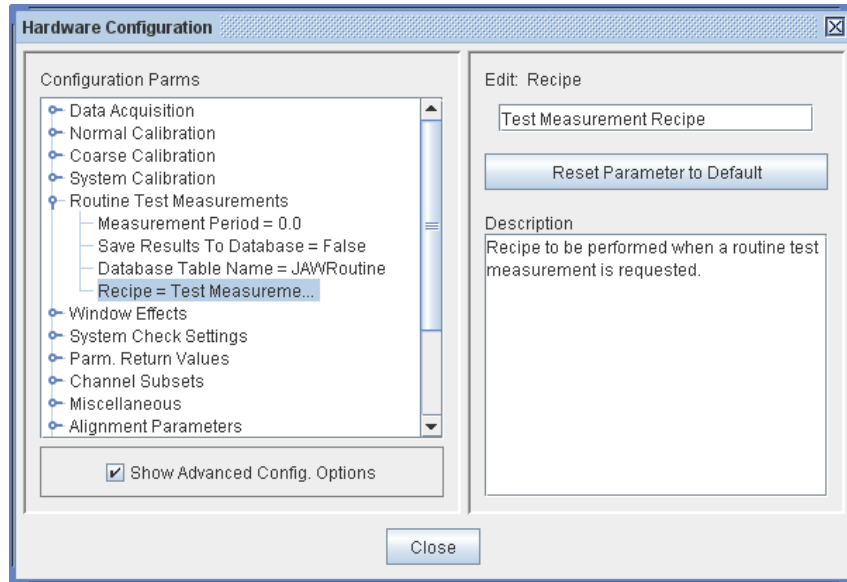


Figure 5-27. Hardware configuration dialog box.

Viewing Results

After completing at least two routine test measurements, the user will be able to view the results by pressing the “Show Results” button in the “Routine Test Measurement” section (see Figure 5-26). The results are displayed on a graph with the parameters plotted versus date. An example is shown in Figure 5-28.

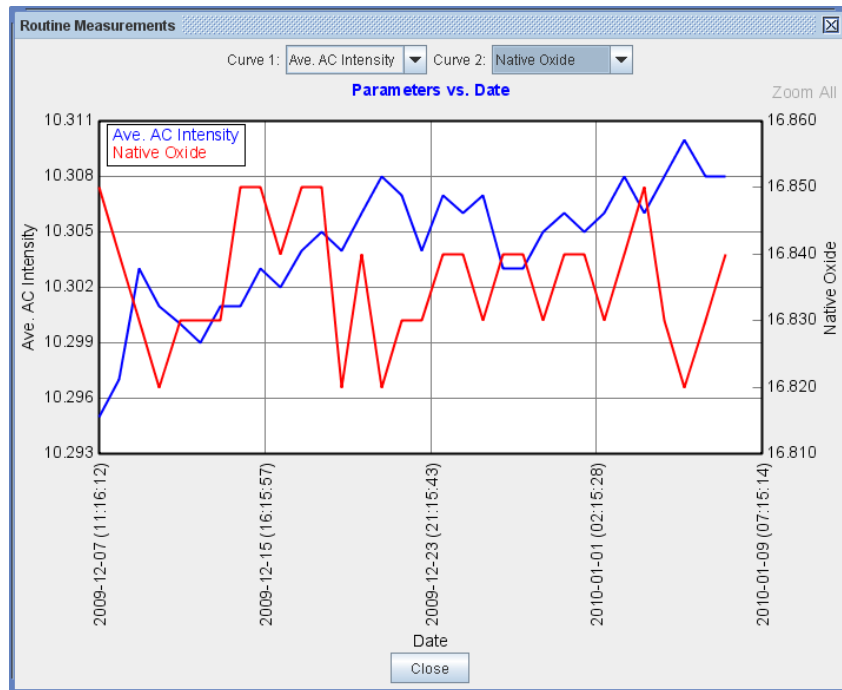


Figure 5-28. Routine Test Measurement results.

6 Focusing Optics

Note: This chapter pertains to removable focusing optics, which is an optional accessory that may or may not have been purchased with your instrument.

6.1 General Overview

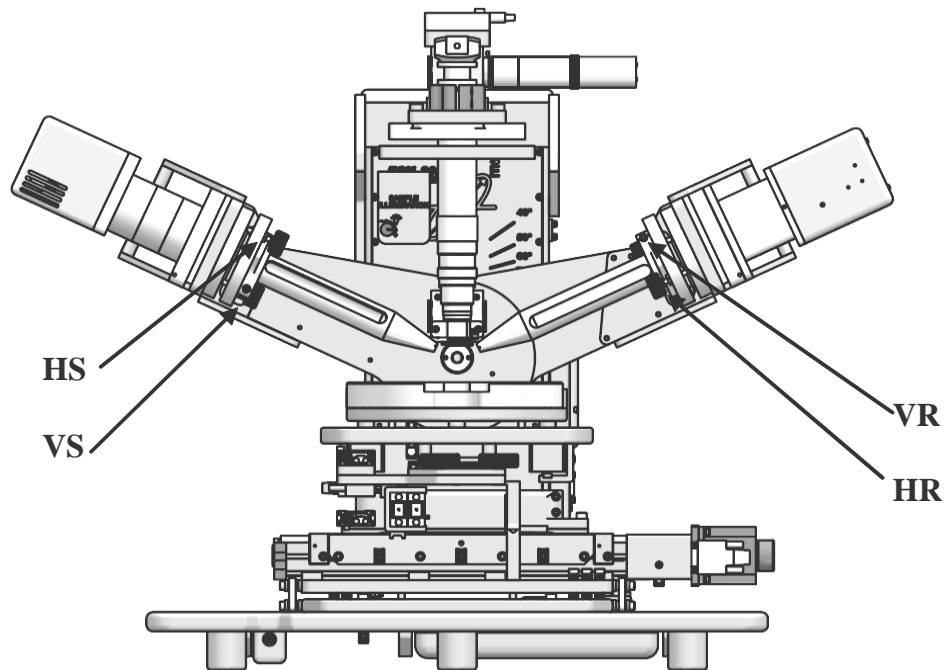


Figure 6-1. Focusing probes.

The focusing optics consists of the Source and Receiver tilt stages and two focusing lens mounts. The tilt stages are used to translate the position of each lens that is mounted in the end of the cone shaped lens mounts. Each tilt stage contains a fine adjustment screw for the vertical position (VS and VR) and the horizontal position (HS and HR). The tilt stages are also equipped with a view port to view the light beam on the Receiver unit aperture.

Related configuration parameters can be viewed by selecting **Hardware>System Information>'Edit Hardware Config'**. Under Focusing Option, the Windows option should be enabled (= true) and set to "Measure Offsets in ST" (= true).

“Use Separate Angle Offsets” may also be enabled (if applicable) – see AOI Correction section of this manual. Check ‘Show Advanced Config. Options’ to see the window effects and delta offsets displayed. DO NOT edit these numbers manually. These are calculated after the alignment is performed. The configuration parameters should not change and do not need to be checked each time the focusing probes are added.

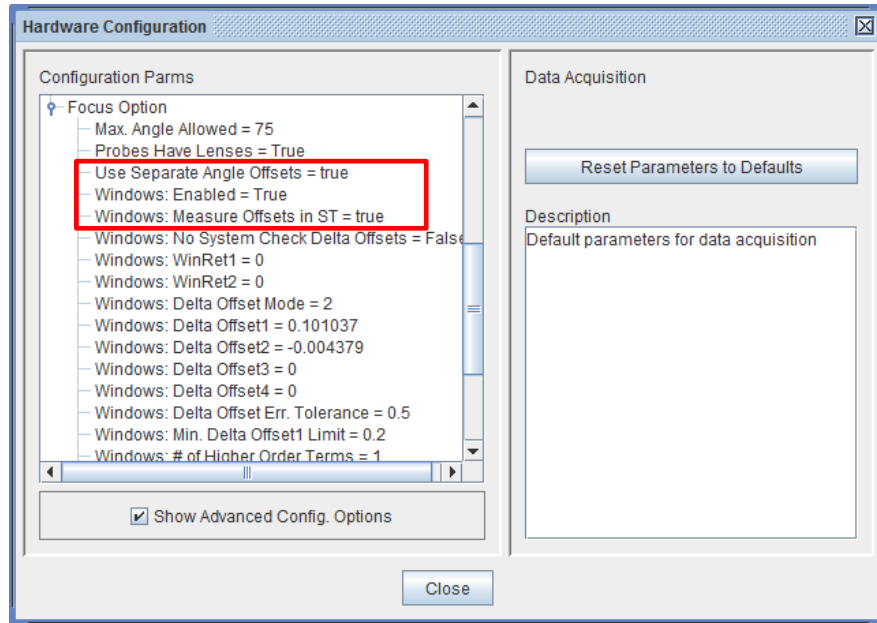


Figure 6-2. Hardware Configuration window.

Caution: The focusing lenses and their coatings can easily be damaged. Be careful when handling the lens mounts so that nothing touches the lenses.

6.2 Installation

Focusing optics should not be installed during the initial Alignment and Calibration Procedures described earlier in this manual. If the system is ready for general use, the focusing optics can be installed using the following procedure.

Caution: Remove any sample positioning pins from the X axis of the sample stage prior to attaching the focusing probes. These pins may prevent proper alignment of the focusing optics or cause damage to the focusing tilt stages due to improper strain.

1. Select **Hardware>Controls>System>‘Install Focus Probes’**.

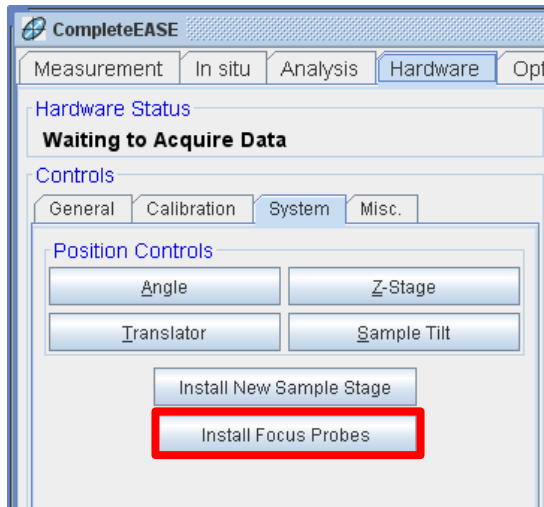


Figure 6-3. Install Focus Probes.

2. Select Yes when prompted to step through the alignment procedure. The system will raise the Z stage and move to the straight-through position (90°).

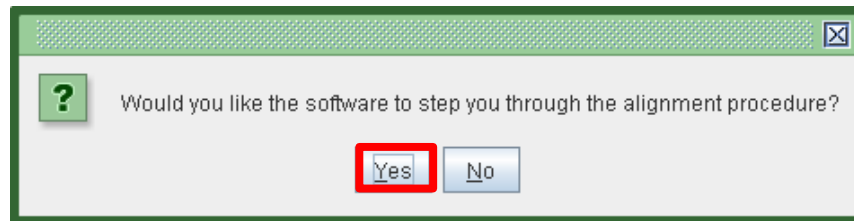


Figure 6-4. Probe alignment message box.

3. Each probe is labeled as Source or Receiver. CompleteEASE will prompt for attaching each probe. This procedure may vary if the Alignment Camera is present in the Receiver Unit.

Standard Receiver Unit

1. The first prompt is to attach the Receiver probe. Using the three captive thumb screws, attach the Receiver focusing probe to the Receiver probe tilt stage.

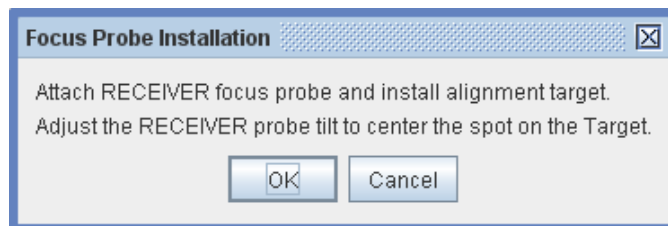


Figure 6-5. Adjust Receiver probe.

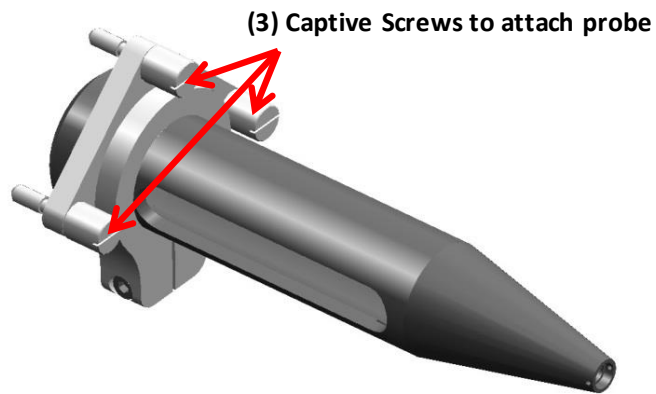


Figure 6-6. Focus probe mounting.

2. Unscrew the cone-shaped Receiver side lens mount and replace with Alignment Target.

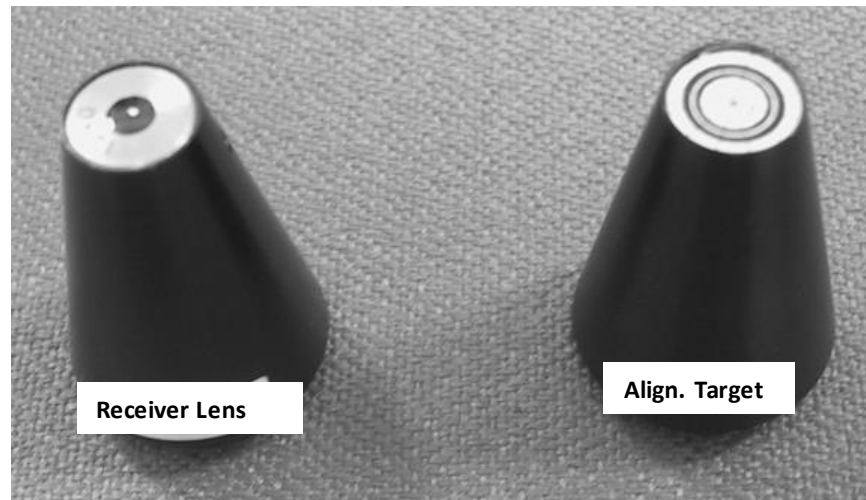


Figure 6-7. Focusing lens and target.

3. Observe the ellipsometer beam on the Alignment Target. For better visibility, reduce the ambient light if possible.
4. Carefully center the beam on the Alignment Target by translating the target with the Vertical Receiver (VR) and Horizontal Receiver (HR) adjustment screws. MOVE THE TARGET, NOT THE ELLIPSOMETER BEAM. Click OK when finished.

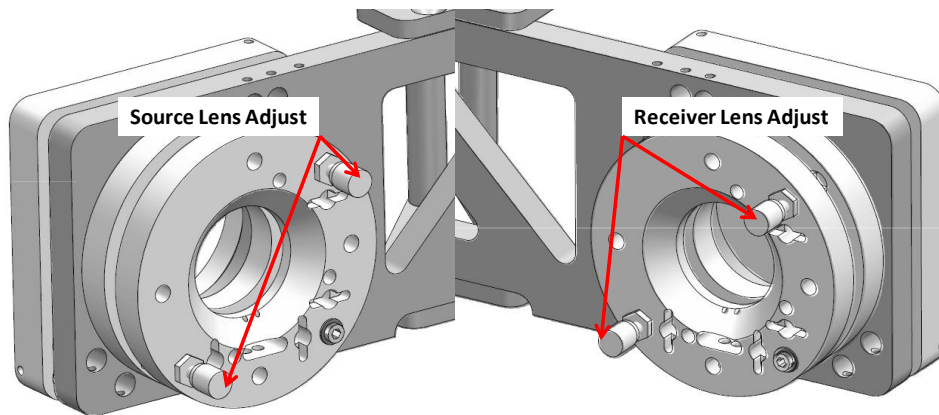


Figure 6-8. Focus Probe Tilt Adjustments.

5. The second prompt is to attach the Source probe. Using the three captive thumb screws, attach the Source focusing probe to the Source probe tilt stage.

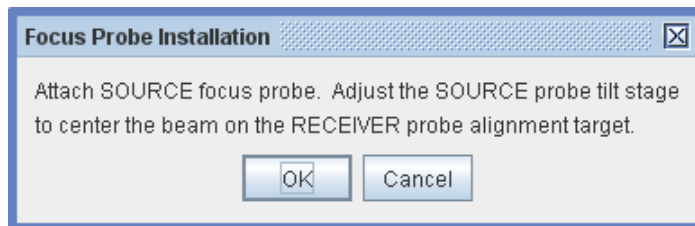


Figure 6-9. Adjust Source probe.

6. Again, observe the ellipsometer beam on the Alignment Target. For better visibility, reduce the ambient light if possible.
7. Carefully center the beam on the Alignment Target by translating the Source side lens with the Vertical Source (VS) and Horizontal Source (HS) adjustment screws. MOVE THE SOURCE LENS, NOT THE TARGET OR ELLIPSOMETER BEAM. Click OK when finished.
8. Follow the next prompt by removing the Alignment Target and replacing it with the Receiver side lens. Click OK when finished.

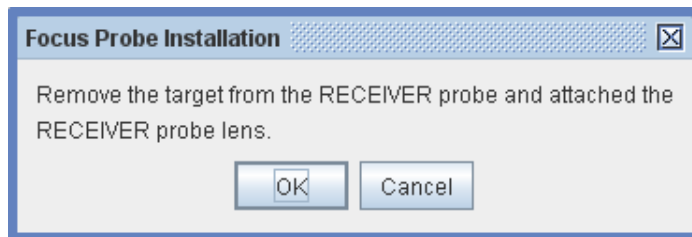


Figure 6-10. Remove target.

9. Lastly, adjust ONLY the RECIEVER LENS (Vertical and Horizontal) adjustment screws to maximize the Intensity. Click OK when finished and go to Section 6.3.

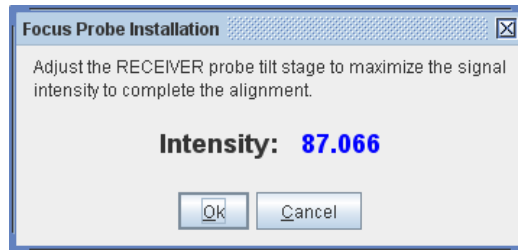


Figure 6-11. Adjust Receiver probe.

Alignment Camera Receiver Unit

1. The first prompt is to attach the Source probe.

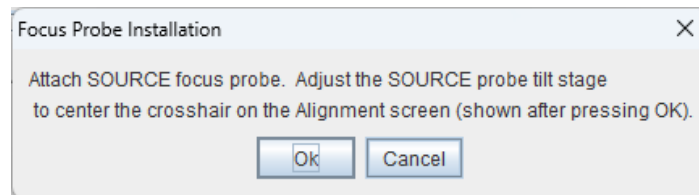


Figure 6-12. Adjust Source probe.

2. Using the three captive thumb screws, attach the Source focusing probe to the Source probe tilt stage. Click OK when finished.

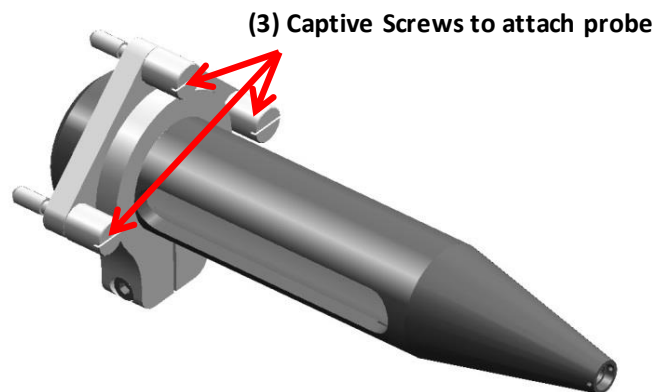


Figure 6-13. Focus probe mounting.

3. Carefully center the cross hair by translating the Source side lens with the Vertical Source (VS) and Horizontal Source (HS) adjustment screws. Close alignment screen when finished.

Note: If the beam is not entering the Receiver Unit at all, 'Out of Range' will be displayed.

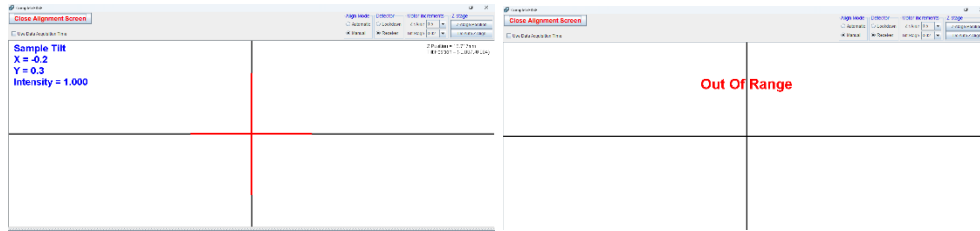


Figure 6-14. Cross hair example – Receiver Camera installed.

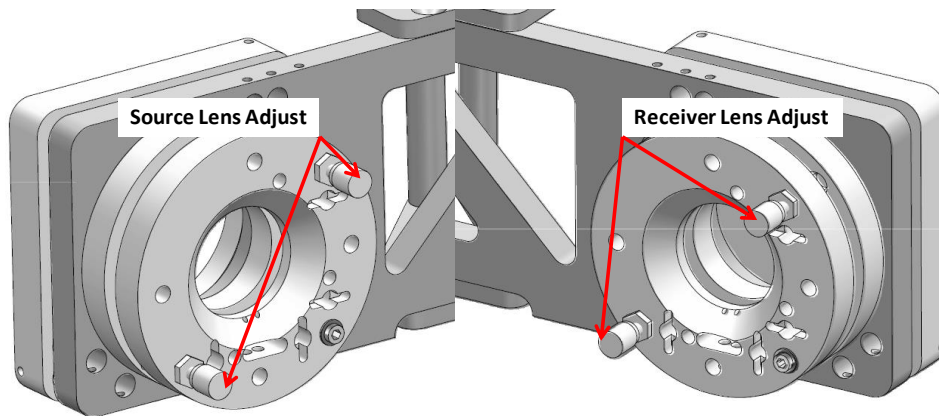


Figure 6-15. Focus Probe Tilt Adjustments.

4. The second prompt is to attach the Receiver probe. Using the three captive thumb screws, attach the Receiver focusing probe to the Receiver probe tilt stage. Click OK when finished.

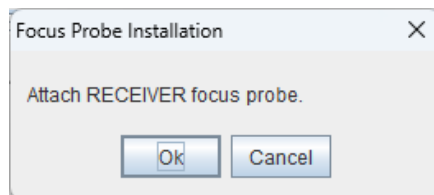


Figure 6-16. Attach Receiver probe.

5. Lastly, adjust ONLY the RECIEVER LENS (Vertical and Horizontal) adjustment screws to maximize the Intensity. Click OK when finished and go to Section 6.3.



Figure 6-17. Adjust Receiver probe.

6.3 Lens Correction

1. The signal screen is displayed at the end of the installation procedure as a chance to optimize the straight-through signal before the measurement is taken. This may be necessary in some system configurations involving the ND filter wheel (see Section 2.2 System Components). When finished, or if no optimization is required, cancel to escape the signal screen.
2. The software will acquire data in the straight-through position and fit for the Delta Offsets introduced by the focusing lenses. These offsets will be written to the Configuration as mentioned earlier.

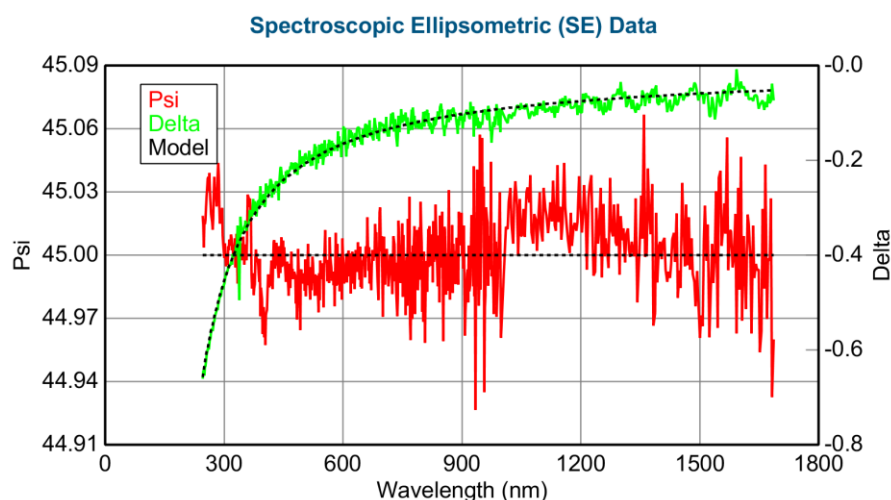


Figure 6-18. S-T data example (Psi and Delta).

3. After the focusing probes are installed, the AOI will move to a safe position (i.e., 70°) and the **Hardware>System Information** panel will update as shown below.

Focus Probes: Installed
Window Effects: ON (Focus Option)

Figure 6-19. Focusing Probes installed.

4. If configured, the software will then automatically correct the Angle Offset and the Receiver Alignment Camera Offset.

Note: With the focusing probes attached, the base cannot be operated in the straight-through position. The limit switches behind the probes prevent the stage from moving past 75° (or 65° in some configurations). This prevents the probes from running into the sample stage and damaging them.

6.4 Sample Alignment & System Check with Focusing Optics

Focusing Optics reduce the measurement beam size to a few hundred microns (exact size depends on system details), and sensitivity to the tip/tilt of the sample stage is greatly reduced. However, sensitivity to Z-height position is greatly increased. Tip/tilt adjustment may be skipped during sample alignment, but Z-height (maximize intensity) should be performed carefully.

1. Place a 25nm SiO₂/Si calibration wafer on the sample stage.
2. Select **Hardware>Controls>General>'Align Sample'**. When prompted to perform a full system alignment, select Yes.

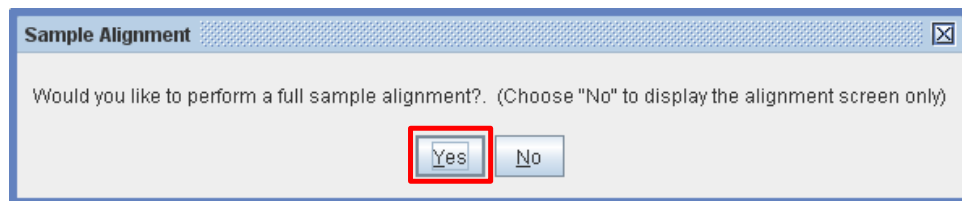


Figure 6-20. Sample Alignment message box.

3. In the Sample Alignment dialog box, select Automatic-Quick in the Sample Height Alignment drop menu. Enter the sample thickness (0.55mm for calibration wafer). Enter 65 in the Alignment Angle box. Press OK.

Note: With the focusing probes attached, the Sample Tilt Alignment does not appear unless the system has the Auto Tip/tilt feature. The system is not as sensitive to tilt with a focused beam on the sample. Z height is very critical.

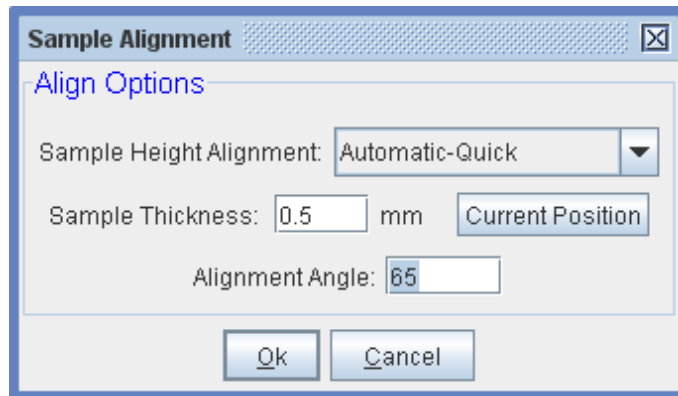


Figure 6-21. Sample Alignment dialog box.

4. The system will perform an Auto-Z height alignment.
 - a. If the Receiver Alignment Camera is installed, Automatic-Camera becomes an option for fast Sample Height Alignment.

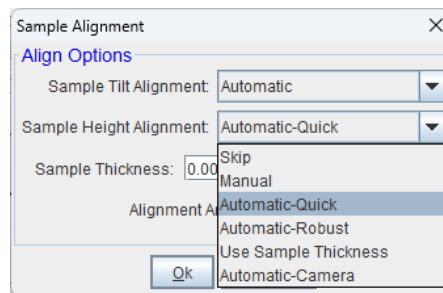


Figure 6-22. Receiver Camera Sample Height Alignment options.

5. Select **Hardware>Controls>General>'System Check'**. Select Yes when prompted to perform the System Check. Press Ok when asked to mount the wafer.
6. In the Sample Alignment dialog box, select Automatic-Quick under the Sample Height Alignment drop menu. If the calibration wafer has already been aligned, click 'Current Position' to enter the current Z-height. Press OK. This will take 1-2 minutes. If the System Check is successful, the system is now ready to take data.
7. If the Psi and Delta data show a "step" at the Detector Switch Point (for NIR systems), the Receiver unit may need to have the iris(es) opened up (shown in Chapter 4). They may have been closed previously to avoid a detector overload, but with the focusing optics present and off sample, they can be opened to allow more light into the fiber(s).

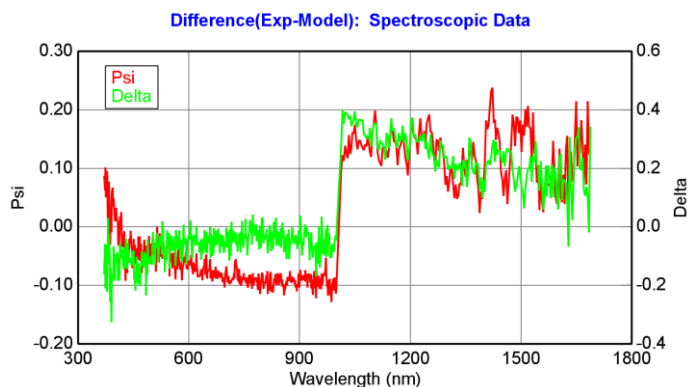


Figure 6-23. Difference plot – Psi/Delta data with step (IR iris not fully open).

8. Open the Receiver Unit irises (if equipped) fully and verify the signal is not overloading the detector by viewing Display Signal screen (**Hardware**>**Controls**>**General**>'Display Signal').
9. Take data again off of the 25nm SiO₂ calibration sample and fit the data with the same model. Now the “step” between UV-VIS and NIR spectrometers should be minimized.

6.5 Data Acquisition with Focusing Optics

With Focusing Probes installed, very small changes in Z (sample height) can cause the reflected beam to miss the Detector. Even an Angle of Incidence change introduces small change in Z. Therefore, the Z alignment (sample height) must be performed at each measured angle.

An advanced hardware option should be turned on to prompt for Z alignment at each measured angle. Select **Hardware**>'Edit Hardware Config' to open the Hardware Configuration window. Check 'Show Advanced Config. Options'. Under 'Alignment Parameters', verify 'Focus Option: Z Align Each Angle = true'.

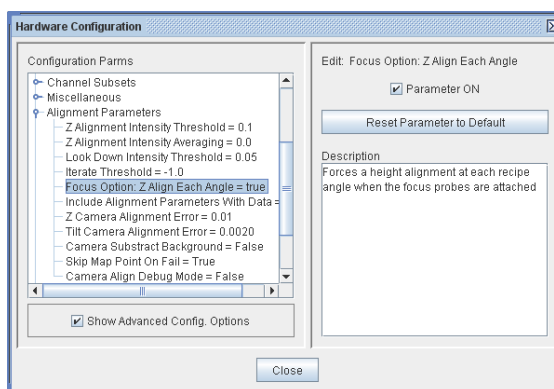


Figure 6-24. Hardware Configuration window.

Angle Offset Correction

Due to alignment sensitivity, the angle offset may need to be corrected each time the Focusing is installed. See section 11.6 Angle of Incidence Offset Correction under the Performance Checks chapter. If equipped with Camera Alignment, this will be done automatically when the Focusing is installed.

6.6 Removal

To remove the Focusing Optics, select **Hardware>Controls>System>'Remove Focus Probes.'** The base will move to the maximum Z height position, maximizing the space between the Focusing Optics and sample stage, and minimizing risk of hitting the sample stage during removal and damaging the optics.

A message will appear letting you know it is safe to remove the Focusing Probes. Loosen the three captive thumb screws for each probe to remove. Store the Focusing Probes with protective caps over the lenses.

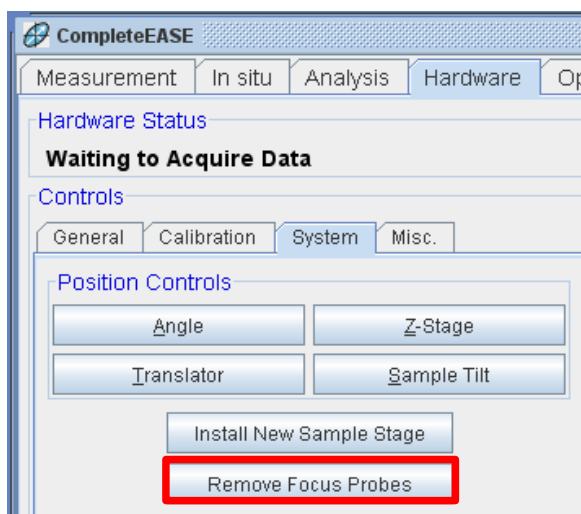


Figure 6-25. Remove Focus Probes button.

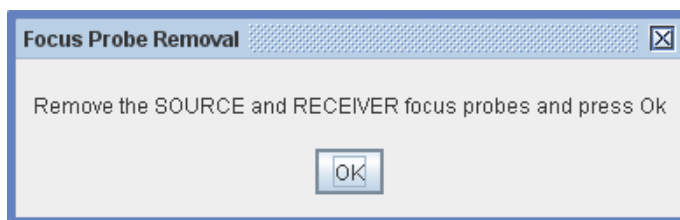


Figure 6-26. Focus Probe Removal message box.

7 Automated Translation (Optional)

Note: This chapter pertains to automated sample translation, which is an optional accessory that may or may not have been purchased with your instrument. This is a generic section; options may vary.

7.1 General Operation

General translator controls are located in the **Hardware** tab. Select **Hardware>Controls>System>'Translator'** to open the Translator dialog box.

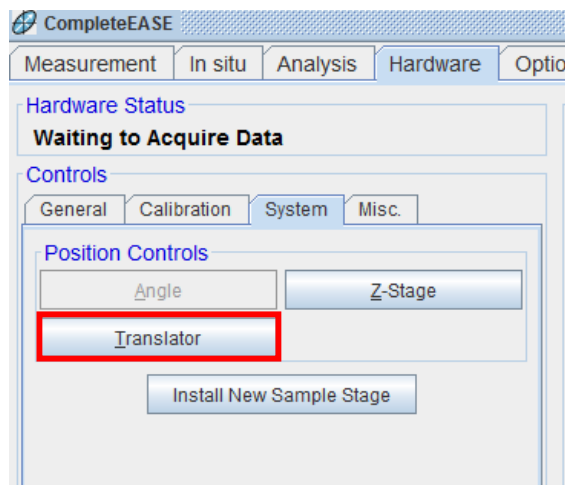


Figure 7-1. Translator controls.

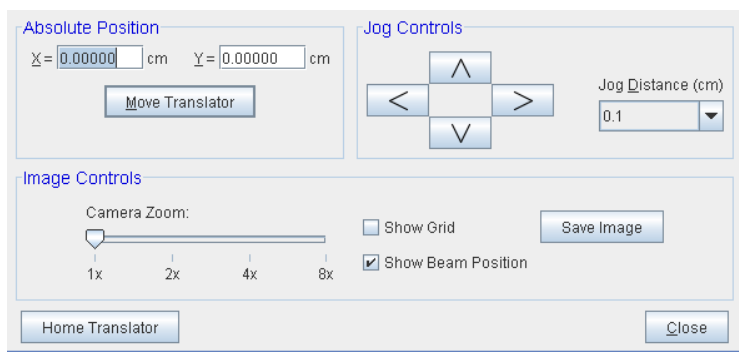


Figure 7-2. Translator dialog box.

The Translator can be moved by entering X and Y coordinates in the **Absolute Position** panel, or by jogging the position left, right, up, and down in the **Jog Controls** panel. The Jog Distance can be varied using the drop-down arrow.

If at any point the translator stage has been manually moved (using knobs on the end of each translator), the software has lost the absolute XY position. To restore, simply click 'Home Translator'. Homing the Translator will move Angle and Z height to a position "safe" for translation. The X and Y Translators will then move to their maximum range, trip hard or soft sensor limits, and reset the software translator tracking.

7.2 Scan Patterns

The primary purpose of the Automated Sample Translator option is to automate sample mapping. This is achieved through a Scan Pattern, which is then used with Data Acquisition Parameters and an Analysis Model in a Recipe.

To create a Scan Pattern, open the Scan Pattern Editor window. From the **Measurement** tab, choose the Recipe option "Create/Edit Recipe". Then, next to Scan Pattern, click "Edit/Create".

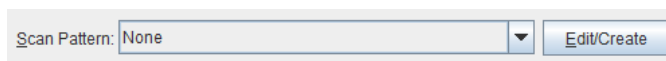


Figure 7-3. Edit/Create Scan Pattern.

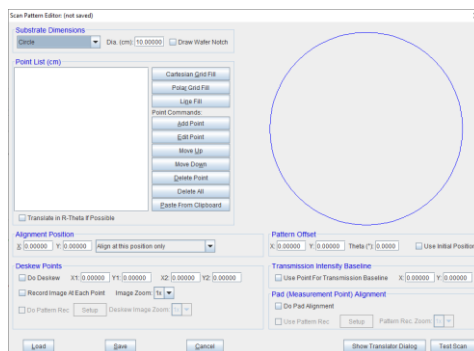


Figure 7-4. Scan Pattern Editor.

The Scan Pattern Editor contains all options available for Scan Patterns including sample size (**Substrate Dimensions**), mapping locations (**Point List**) alignment options (**Alignment Position**), scan offsets (**Pattern Offset**), and more.

Substrate Dimensions

The substrate dimensions can be drawn as a Circle or Rectangle. For circular substrates, the diameter must be entered, and a Wafer Notch can be added if applicable.

For rectangular substrates, the X and Y dimensions must be entered. Scan Patterns for rectangular substrates can be easily set with (0,0) position at the center of the sample, or at the corner of the sample.

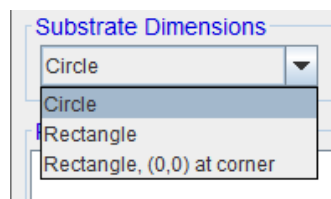


Figure 7-5. Options for Substrate Dimensions.

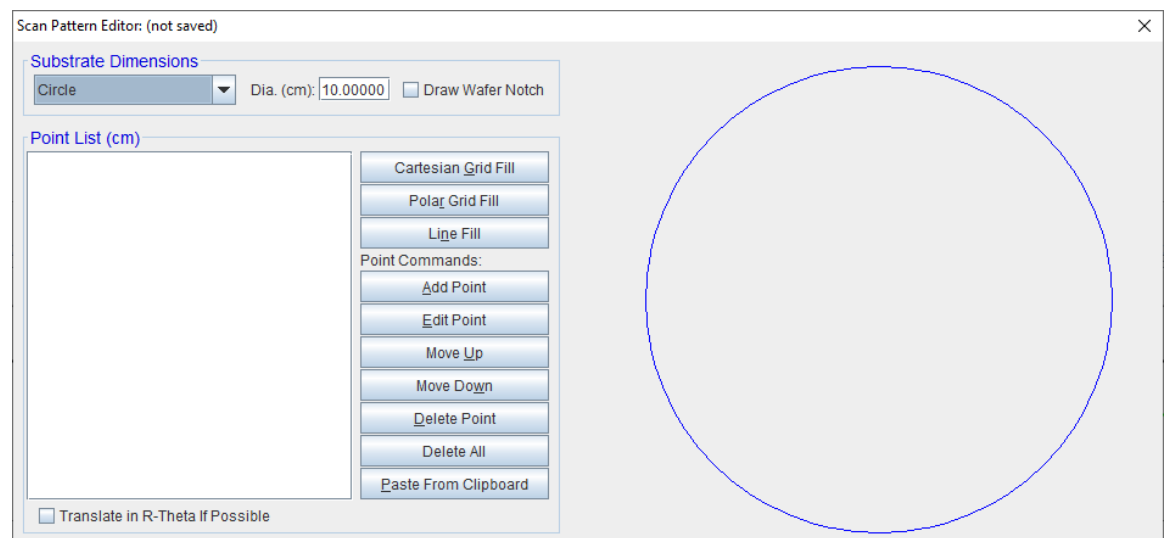


Figure 7-6. Circular sample 10cm diameter.

Point List and Point Commands

The **Point List** panel is used to add mapping locations to the Scan Pattern. Points can be added one at a time, or using a fixed spacing and grid style.

To add points one at a time, or from a preset list of coordinates, simply click 'Add Point'. A measurement point is added using X and Y coordinates or the current Translator position. A list of coordinates created in another program can also be added using the 'Paste From Clipboard' button.

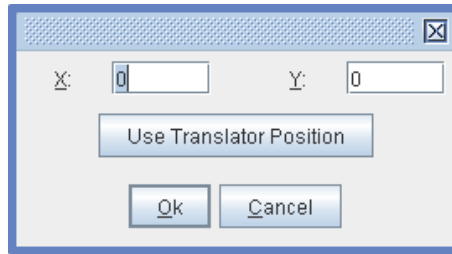


Figure 7-7. Add Point.

As points are added, representative dots will appear in the diagram. Click on a specific point in the point list to select for Point Commands. The selected point appears **blue** in the diagram.

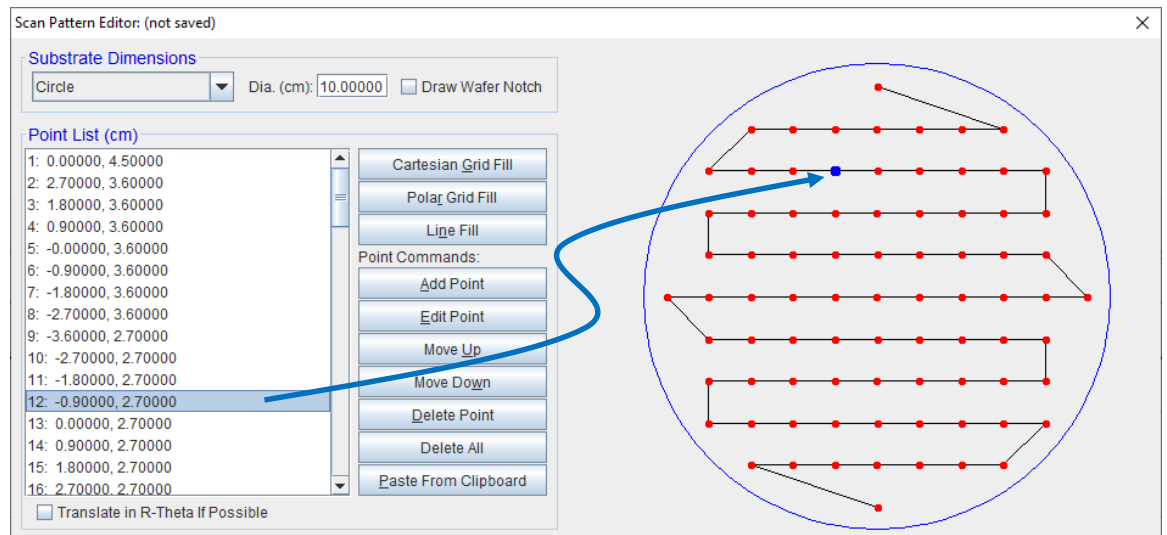


Figure 7-8. Highlighted point in point list.

Use 'Edit Point' to change selected point coordinates.

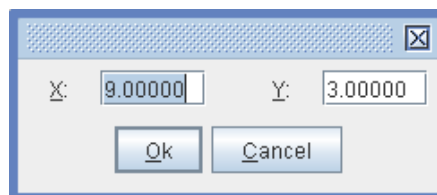


Figure 7-9. Edit Point.

Use 'Move Up' and 'Move Down' to move selected point up or down on the Point List. The sequence of the point list is the order in which locations will be measured.

'Delete Point' removes the selected point from the Point List. 'Delete All' removes all points from the Point List.

Grid and Line Fill

To add points using a fixed spacing and grid style, use the ‘Grid Fill’ and ‘Line Fill’ buttons. Each option opens a different window.

For a Cartesian Grid Fill, the Grid Spacing, Grid Margin, and Grid Style (i.e. Square or Hexagonal) must be specified.

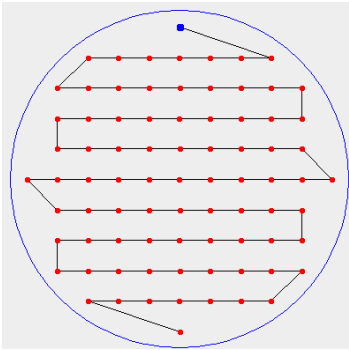
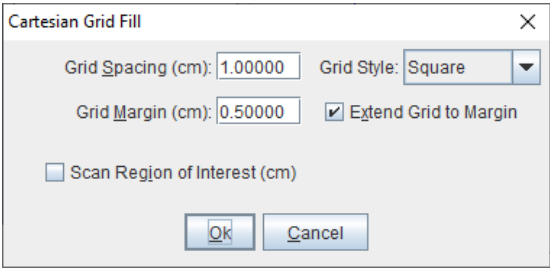


Figure 7-10. Cartesian Grid Fill.

For a Polar (R-Theta) Grid Fill, the Radius and Theta values must be specified.

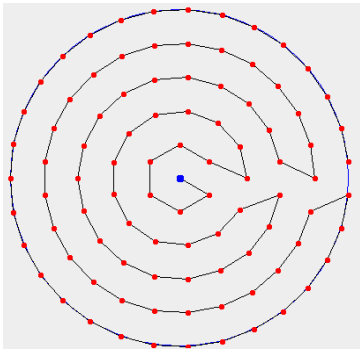
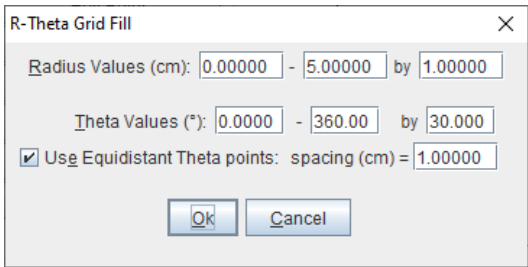


Figure 7-11. R-T Grid Fill.

For a Line Fill, the Line Direction, Grid Spacing, Grid Margin, and X or Y Axis Coordinate must be specified. Multiple Line Fills can be added.

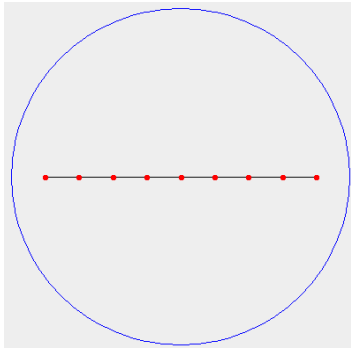
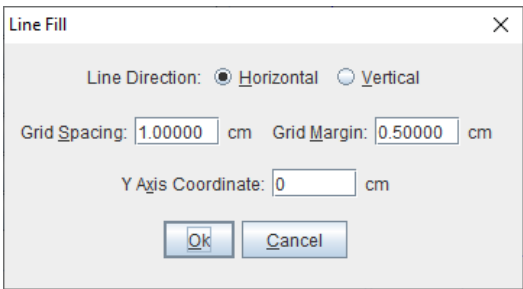


Figure 7-12. Line Fill.

Test Scan

The measurement locations can be tested using the 'Test Scan' button. Click this button to observe the translator movement before committing to a full measurement. Use 'Move to Next Point' to step through all points in the scan.

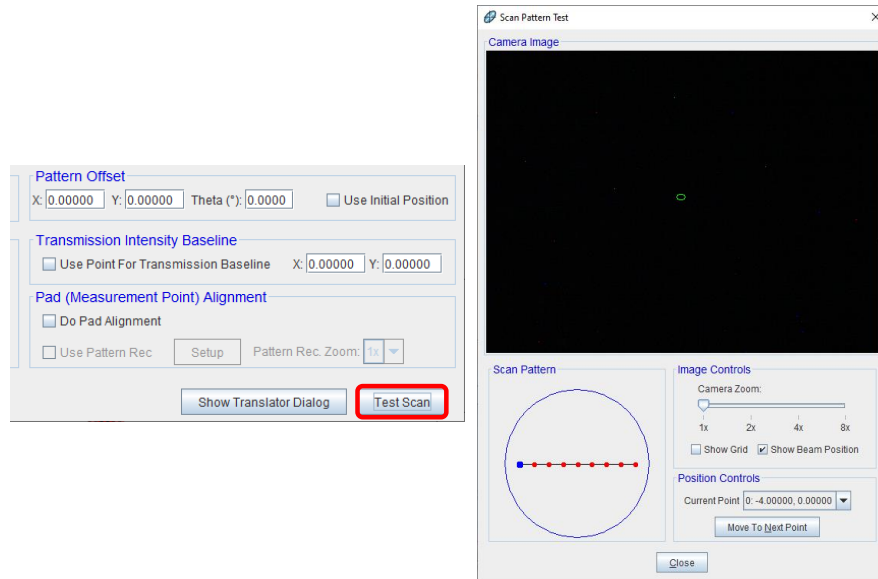


Figure 7-13. Scan Pattern Test.

Note: A 180° Pattern Offset may be required for correct orientation of wafers with wafer notch. Use the 'Test Scan' function to confirm desired orientation.



Figure 7-14. Pattern Offset options.

Alignment Position

Alignment options must be specified for each Scan Pattern. Available alignment options are found in the Alignment Position panel, shown in the figure below. The ideal alignment option can depend on several factors including desired measurement time, flatness of sample, and uniformity of sample”

- For measurements on a flat semiconductor wafer, with uniform film, and normal light beam (no focusing optics), full alignment at the center location only may be adequate.
- For measurements on a wedged substrate, full alignment at all points may be necessary.
- For measurements with Focusing Optics, a Z alignment at all points is likely necessary, as the focused beam is highly sensitive to small changes in Z height.

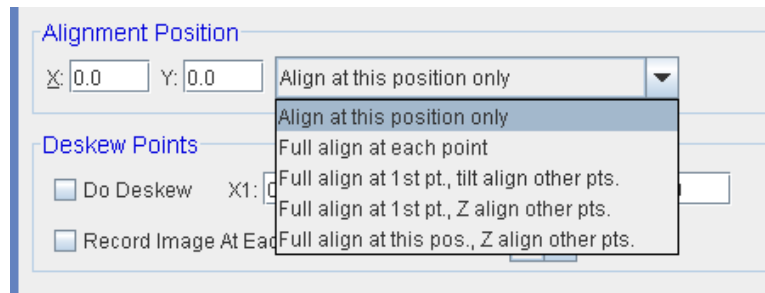


Figure 7-15. Alignment Position.

Save

When all Scan Pattern options have been specified, click ‘Save’ to save the Scan Pattern for use in a Recipe.

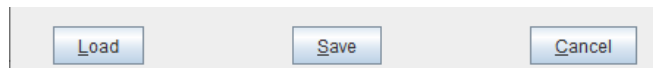


Figure 7-16. Save Scan Pattern.

7.3 Rotator Option

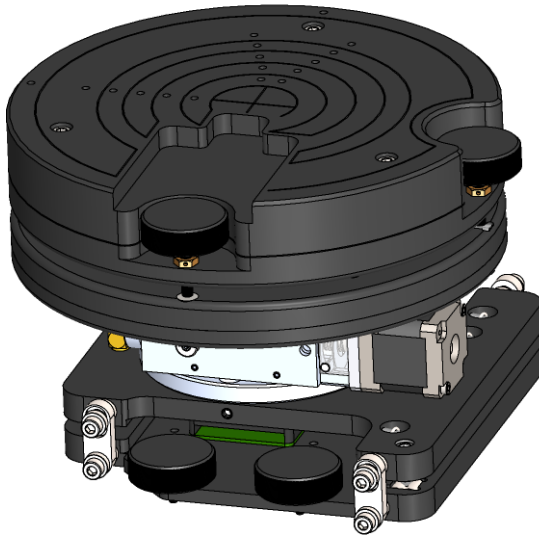


Figure 7-17. Sample Rotator.

The Sample Rotation Stage is an available option to allow for the sample to rotate during measurement. The sample tilt is manual.

Note: The Lookdown Detector option is always included with the Rotation Stage to allow for wobble correction and can be used for sample tilt alignment.

When creating a scan pattern, using the R-Theta option may also be considered.

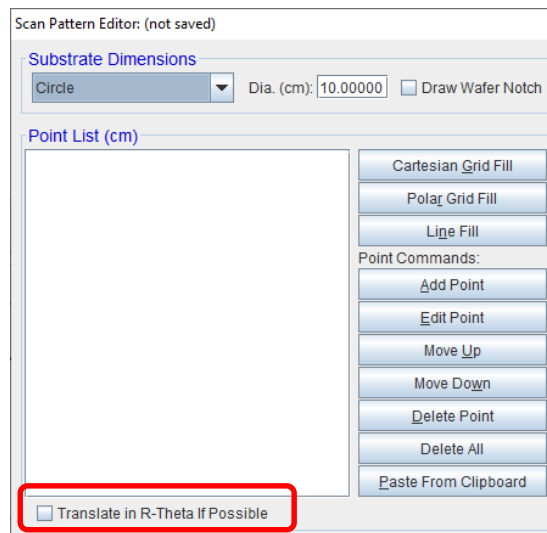


Figure 7-18. Scan Pattern Editor – R-Theta option.

Wobble Correction

In order to measure without aligning at each rotator (theta) angle, the wobble must be removed from the sample stage.

1. Mount and align the sample (refer to Section **Error! Reference source not found. Error! Reference source not found.**) with the theta position at 0°.
2. Select **Hardware>Controls>System>**‘Translator’ (or ‘Rotator’) and move the theta position to 180°.

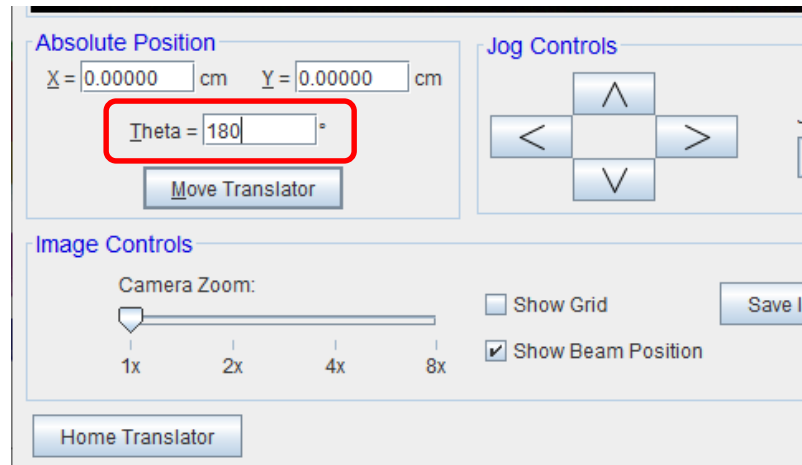


Figure 7-19. Translator Position dialog.

3. Adjust the Sample Tilt to move the Lookdown cross hair position half of the distance it has changed.

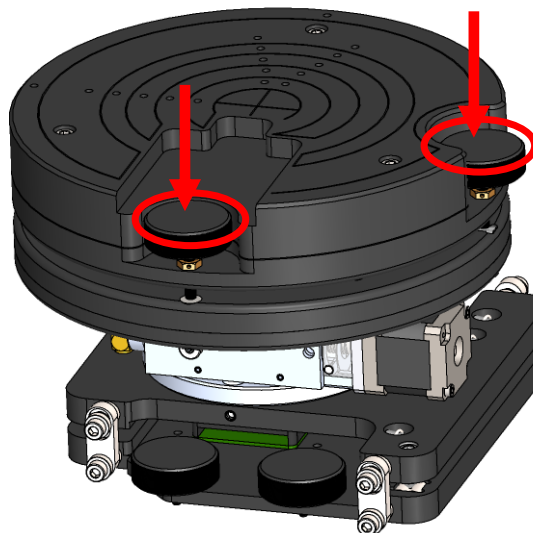


Figure 7-20. Sample Tilt adjustment.

4. For example, if X=8, Y=-6.5 : adjust so X=4, Y=-3.25.

Note: If it is too far off (not detected), the Receiver Detector (or visual beam position) can be used as a coarse alignment.

5. Move the theta position to 0° and confirm the cross hair position has not changed.
6. Repeat until the position is stable (typically within ± 2 units).
7. Loosen the tilt stage lockdowns (2 on front and 2 on back) and adjust the tilt plate so the cross hair is centered.

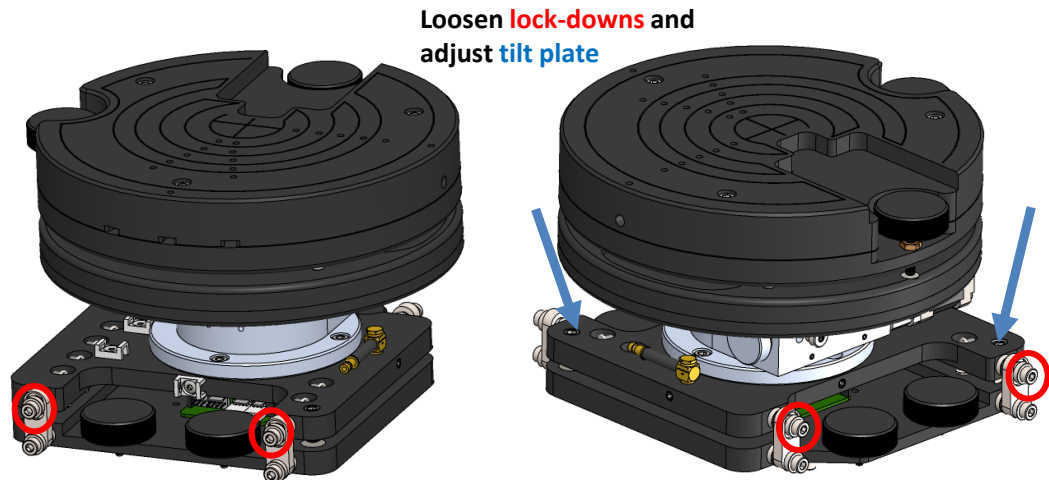


Figure 7-21. Bottom Tilt Plate adjustment.

8. Confirm the procedure, lockdown the bottom tilt plate, and the sample is ready for measurement.

8 Sample Camera

This chapter pertains to an optional accessory that may or may not have been purchased with your instrument. There are two types of imaging cameras covered in this Chapter. Each of which has different capabilities and alignment procedures.

Note: Instructions in this chapter are assuming focusing lenses are attached in order to view the measurement beam on the sample.

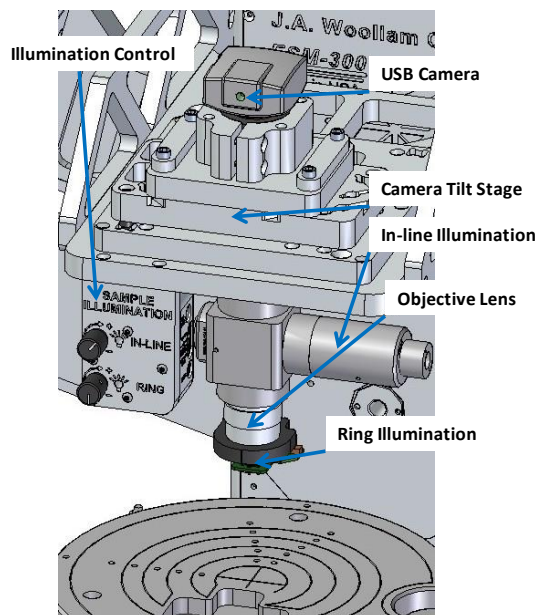


Figure 8-1. Standard Camera example (may vary based on model).

Illumination Control

There are (2) types of illumination on the Standard Camera – “Ring” and “In-Line.” These can be used to view the sample image using the camera.

- Ring Illumination – useful for non-reflective (rough) surfaces.
- In-Line Illumination – useful for reflective (“mirror-like”) surfaces.

8.1 Marking the Measurement Beam Position

Note: This is only necessary once, unless the configuration files have been lost (done at the factory setup). The Camera adjustment should be done so the measurement beam is positioned on the center of the camera image.

1. Align the 25nm calibration wafer on the standard sample stage. The Sample Tilt position is now set.
2. Flip the sample over so the rough side is facing up, or use a glossy business card (recommended). If the business card is used, place it on sample stage. Then, perform an intensity-based (Automatic-Quick) Z height alignment (be sure to SKIP the tilt alignment).

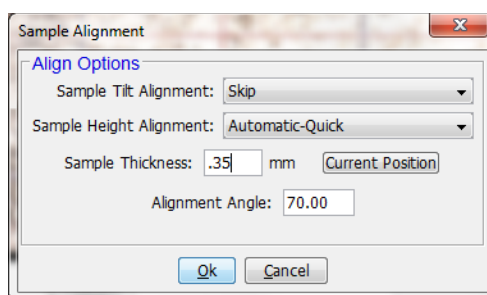


Figure 8-2. Sample Alignment – Intensity-based Z only.

3. Select **Hardware>Controls>Misc** 'Additional Camera Functions' to open the Camera Functions Window. Select 'Mark Measurement Beam Location'. This is going to be used to set the “beam size” and not the “beam position.” Use the appropriate camera adjustment so the beam position remains in the center of the image.

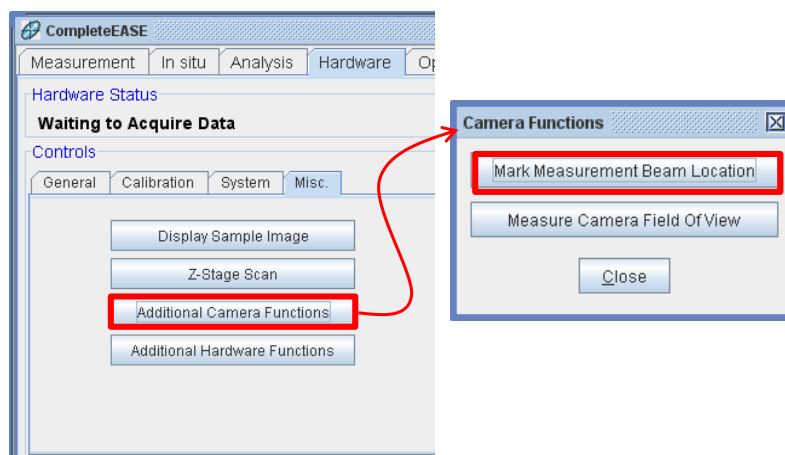


Figure 8-3. Additional Camera Functions – Mark Measurement Beam Location.

Note: The objective lens is fixed, but the digital zoom may be used if desired.

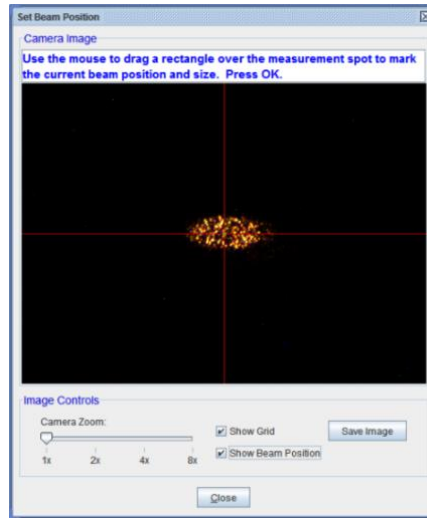


Figure 8-4. Set Beam Position window.

- a. **Standard Camera.** If necessary, tilt the standard camera to center the beam on the screen. Use the diagonal adjustment screws of the camera tilt stage, shown in Figure 8-5. If the camera image is not in focus, adjust the Z height of the camera by turning each adjustment screw on the tilt stage by the same amount.

Turn all (3) adjustment screws by the same amount in the same direction to move the camera in the Z direction.

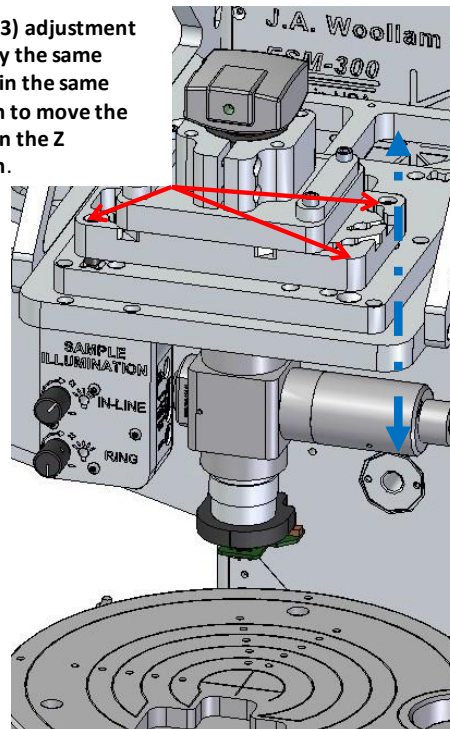


Figure 8-5. Standard Camera adjustment.

- b. **Z Align/Imaging Camera.** If the camera image is not in focus, loosen the lock-down on each side and adjust the Z position of the camera by turning the adjustment screw. Tighten the lock-downs.

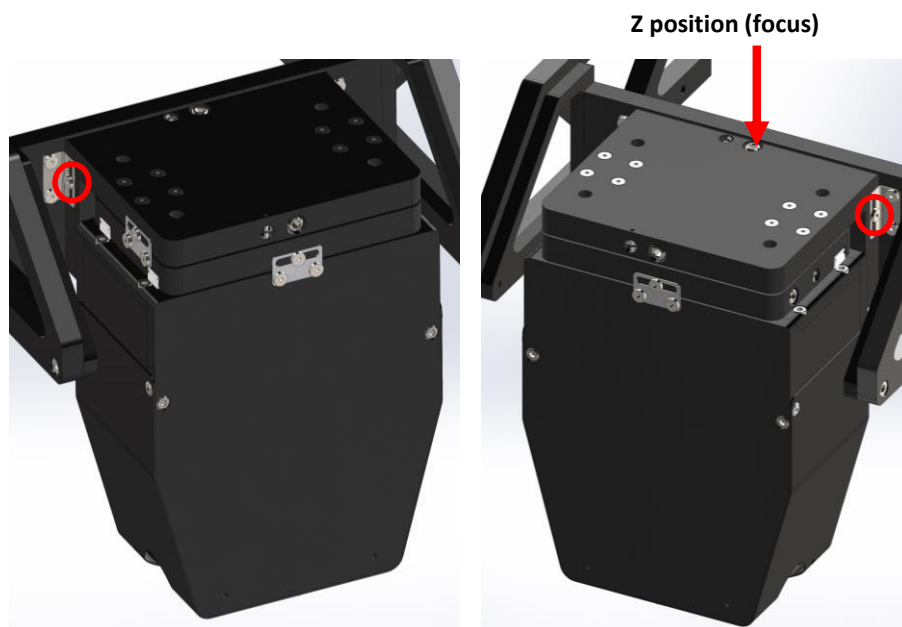


Figure 8-6. Z Align/Imaging Camera Z position adjustment.

- i. If necessary, **translate** the Z/Imaging Camera to center the beam on the screen. Remount the business card and perform Intensity-based Z alignment again or flip calibration wafer over to rough side.

Loosen lock-downs and Translate

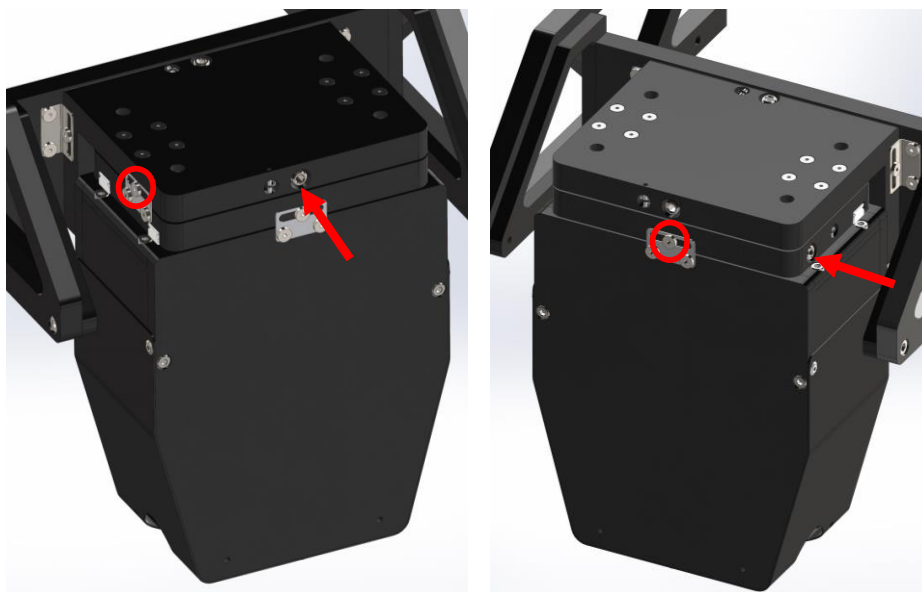


Figure 8-7. Z Align/Imaging Camera translation adjustment.

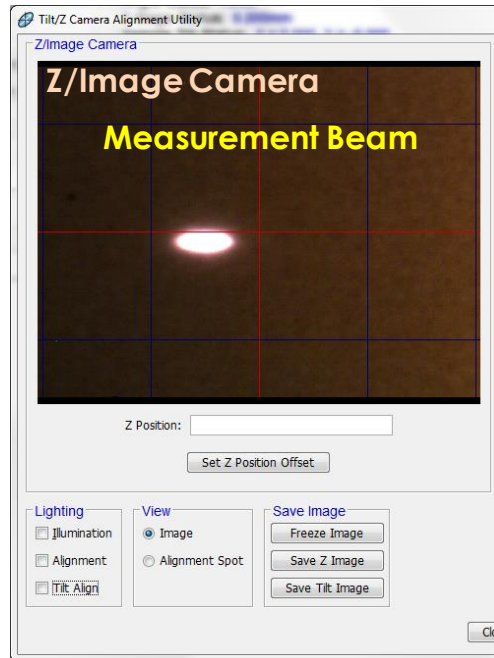


Figure 8-8. Measurement beam on Z/Image Camera.

- ii. After translating the camera, the offset(s) must be calibrated again.
- iii. Mount the 25nm calibration wafer on the standard sample stage. The Sample Tilt position remains as it was in Step 1. Perform the Sample Height Alignment only, but selecting **Hardware>Controls>General>'Align Sample'**. When prompted to perform a full system alignment, select 'Yes'.

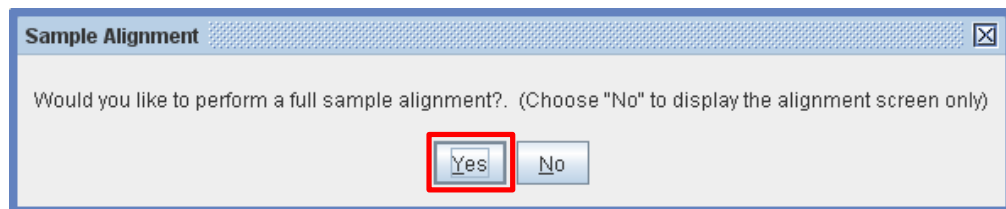


Figure 8-9. Sample Alignment message box.

- iv. Under the Sample Tilt Alignment drop down menu, select 'Skip'. Under the Sample Height Alignment drop down menu, select 'Automatic-Quick'. Enter the sample thickness into the box. (Cal. Wafer $\approx 0.55\text{mm}$). Press 'Ok'.

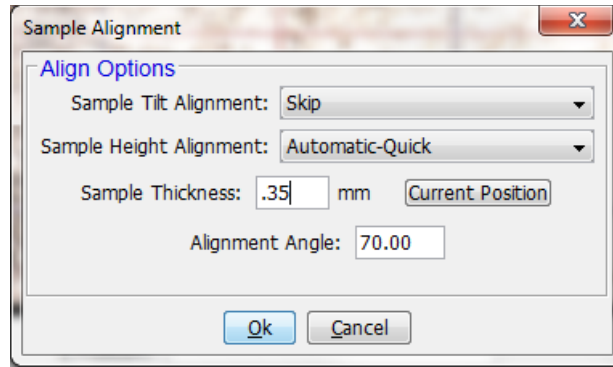


Figure 8-10. Sample Alignment – Intensity-based Z only.

- v. Select **Hardware>Controls>Misc>'Additional Hardware Functions'** to open the Hardware Functions window and calibrate the Camera Alignment Offset(s):
 - a. Calibrate Z Alignment Camera
 - b. Calibrate Tilt Alignment Camera

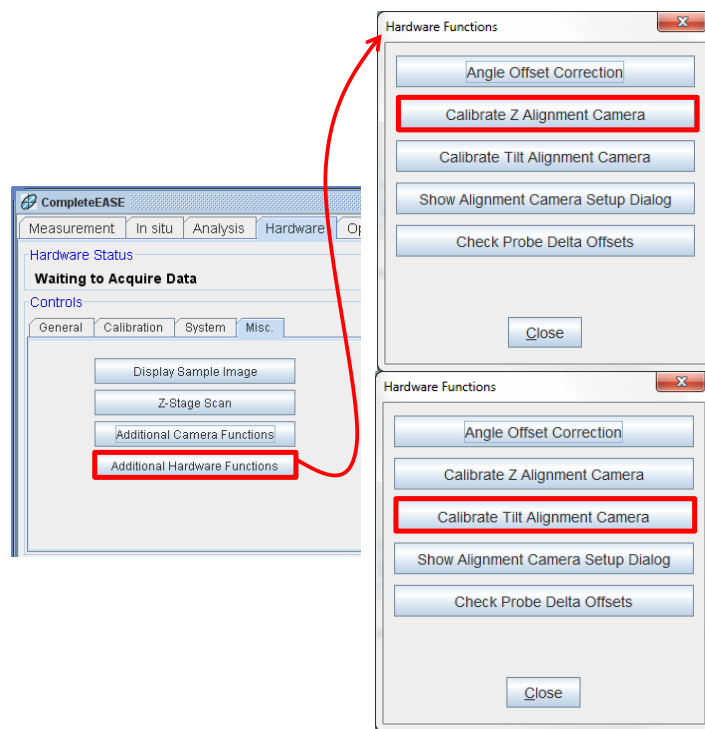


Figure 8-11. Camera Calibration.

- 4. To re-open the 'Set Beam Position' dialog (if necessary), select **Hardware>Controls>Misc>'Additional Camera Functions'** and choose 'Mark Measurement Beam Location'.
- 5. Follow the instructions at the top of the window: "Use the mouse to drag a rectangle over the measurement spot to mark the current beam position and

size.” This may be performed as many times as needed; it will not save until the window is closed.

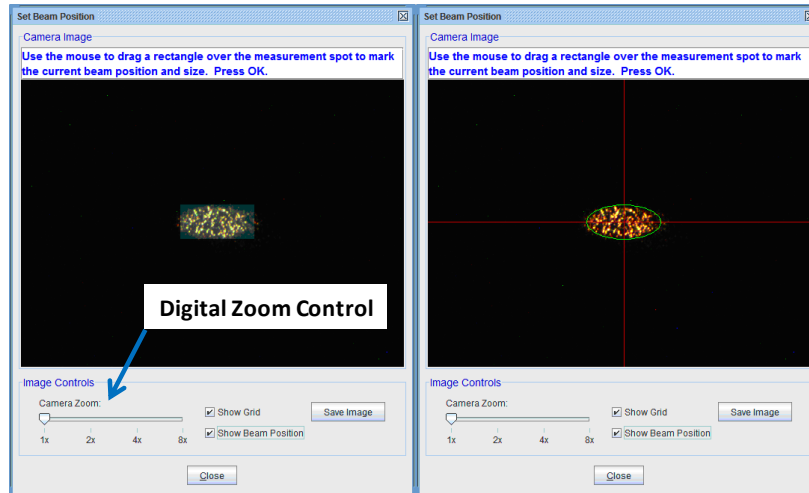


Figure 8-12. Set Beam Position.

6. Close the window when finished.

Lookdown Camera LED Spot vs. Measurement Beam Location

If the sample under measurement is a small area, it is critical to verify that the alignment LED spot(s) is co-located with the measurement beam.

1. Align the 25nm calibration wafer on the standard sample stage. The Sample Tilt position is now set.
2. Flip the sample over so the rough side is facing up, or use a glossy business card (recommended). If the business card is used, place it on sample stage. Then, perform an intensity-based (Automatic-Quick) Z height alignment at the desired AOI.

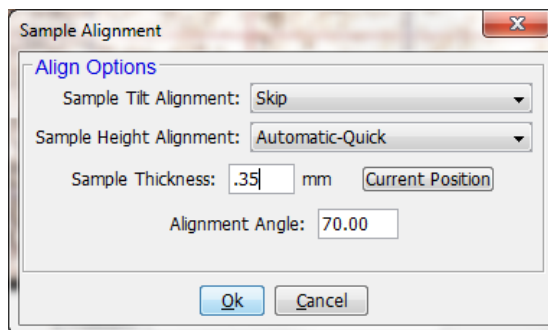


Figure 8-13. Sample Alignment – Intensity-based Z only.

3. Block the measurement beam to view only the Alignment beam(s).
4. Verify the Tilt Align Beam first. Select **Hardware>Controls>Misc>'Additional Hardware Functions'** to open the Hardware Functions

window. Select “Show Alignment Camera Setup Dialog”. Select the “Tilt Align” check box only.

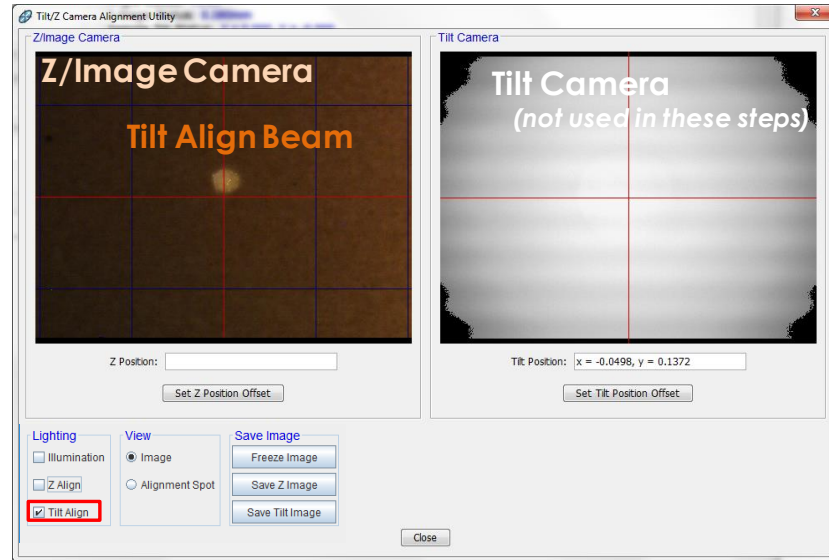
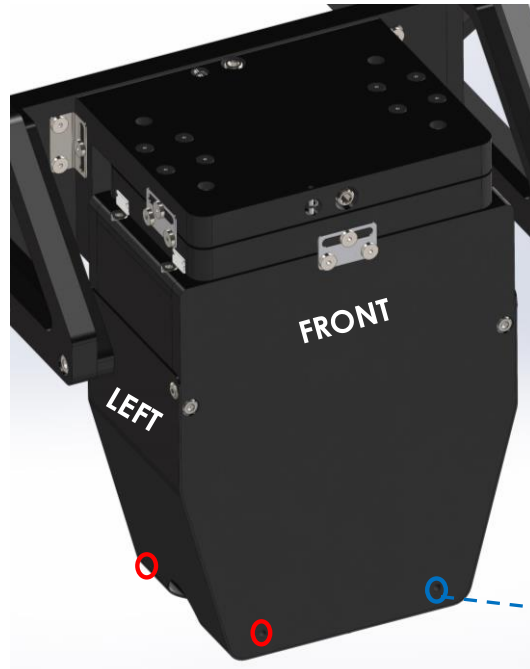


Figure 8-14. Tilt Align Beam on business card – not centered.

5. Adjust the Camera Position to the Tilt Align Beam using the “Imaging Camera Translation” (left side access holes) to center.

Imaging Camera Translation



Z LED Adjust



Figure 8-15. Camera Fine Adjustment access holes.

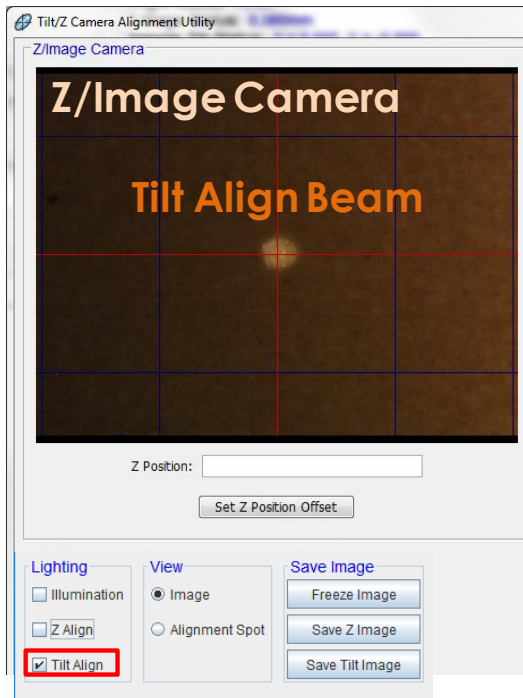


Figure 8-16. Tilt Align Beam centered on Imaging Camera.

6. Verify the Z Align Beam next. Select the “Z Align” check box. Adjust the “Z LED Adjust” (right side access holes – see Figure 8-15) to center.

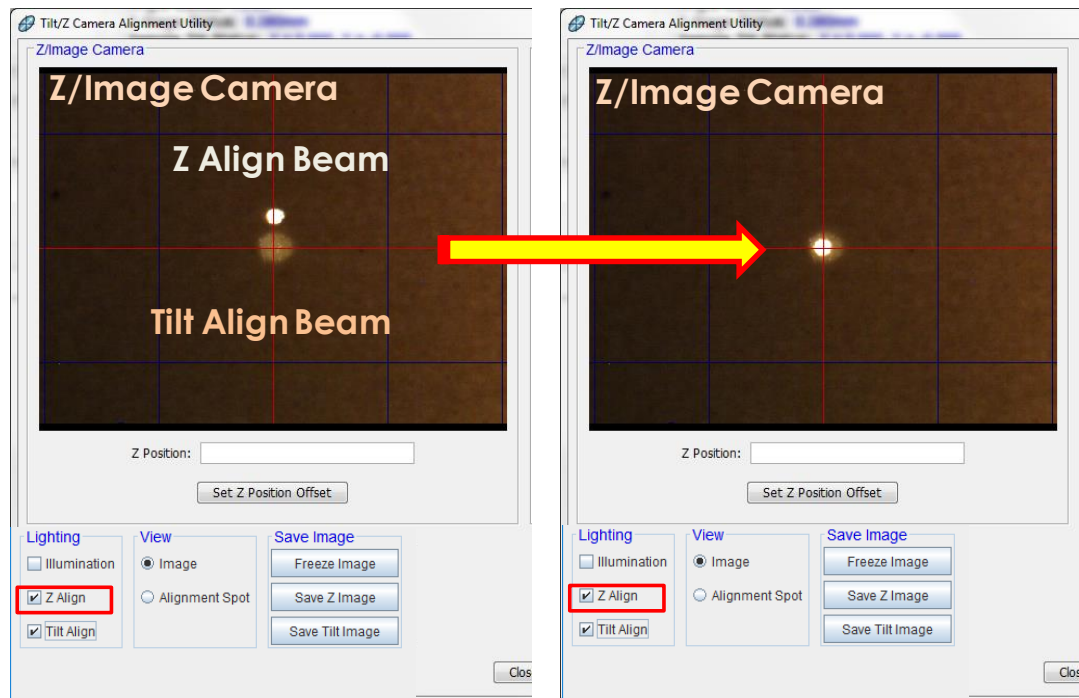


Figure 8-17. Z Alignment Beam centered on Imaging Camera.

7. Unblock the Measurement Beam. Repeat the previous section, Marking the Measurement Beam Position, to verify the Camera position.

8.2 Field of View Calibration

Note: This is only necessary once unless the configuration files have been lost (done at the factory setup). So, the “point and click” function can simply be verified before performing the calibration.

1. The previous section (Marking the Measurement Beam Position) should be completed before proceeding.
2. Select **Hardware>Controls>Misc>‘Additional Camera Functions’** to open the Camera Functions Window. Select ‘Measure Camera Field of View’.

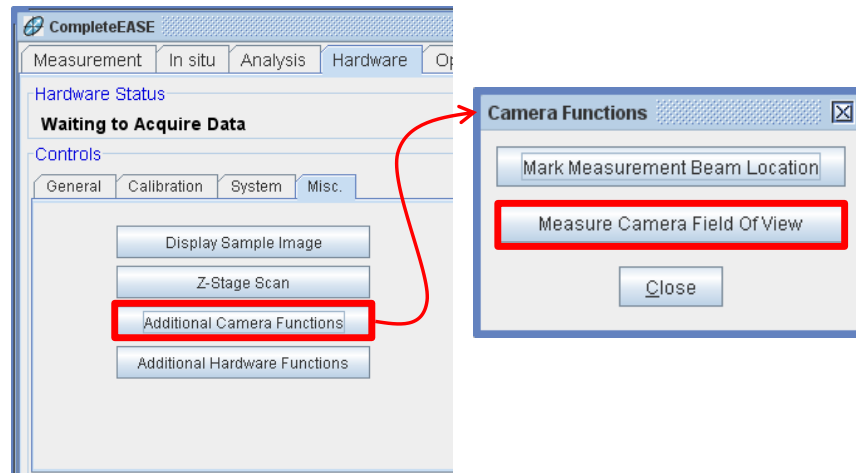


Figure 8-18. Additional Camera Functions button – Measure Camera Field Of View.

3. Adjust the illumination, if applicable, so the sample surface is visible.

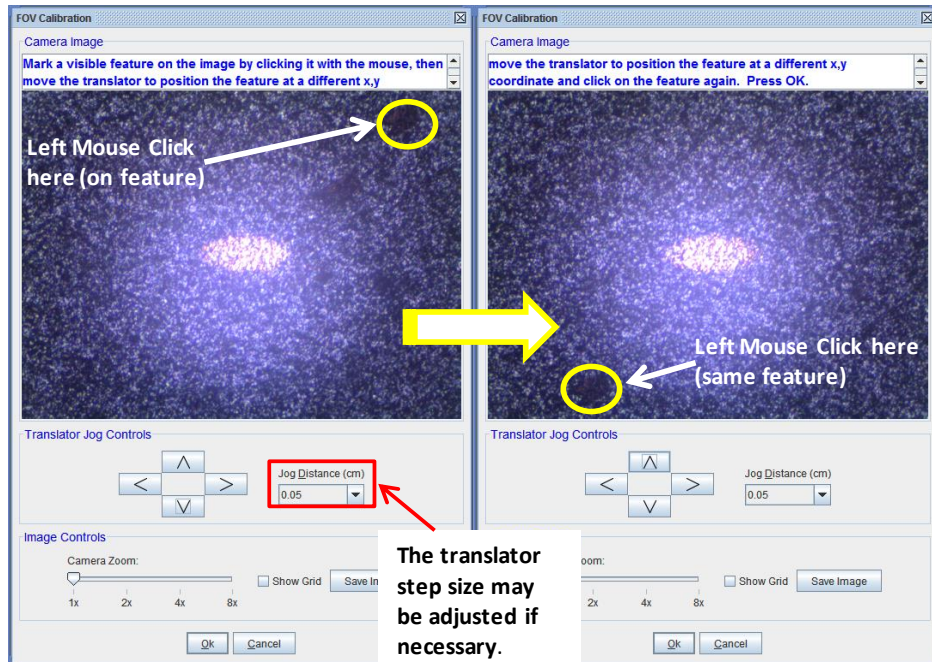


Figure 8-19. Field of View calibration procedure.

4. Follow the instructions at the top of the window: “Mark a visible feature on the image by clicking it with the mouse, then move the translator to position the feature at a different (x,y) coordinate and click on the feature again.” Use a fine tip marker to “create” a feature if necessary. (See Figure 8-19)
5. Press OK when finished.

Note: If not performed correctly, or not sure, just press Cancel and start again.

6. To test the feature, open the Translator Window by selecting **Hardware>Controls>System>‘Translator.’**

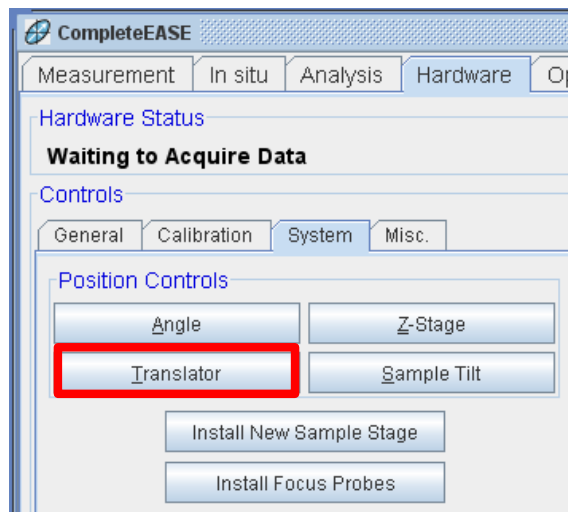


Figure 8-20. Click ‘Translator’ to open Translator window.

7. Click on the feature and the translator should move it to the Beam Position.

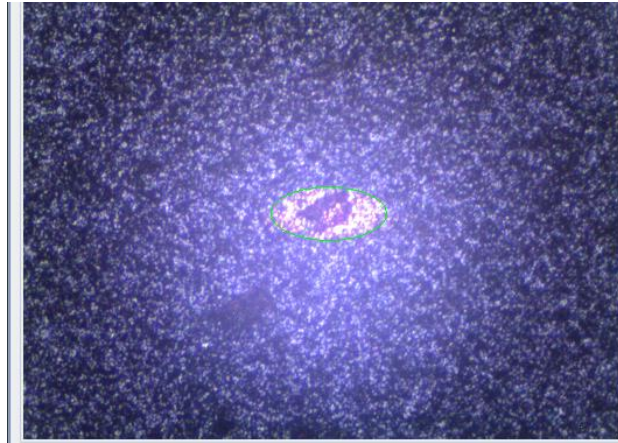


Figure 8-21. Field of View calibration test result.

9 In Situ

Note: In situ mounts are an optional accessory that may or may not have been purchased with your instrument.

If components are available and it is desired to move the system in situ on a process chamber, the software must be configured correctly. There is line option in the hardware.cnf file to allow this function (AllowInSitu=Yes). If present, the user can specify that the instrument is to be used in situ on the next initialization. This is done to avoid the error messages regarding the AOI, Z-Stage, and other optional motors. The software will not attempt to move these motors until the in situ function is reversed.

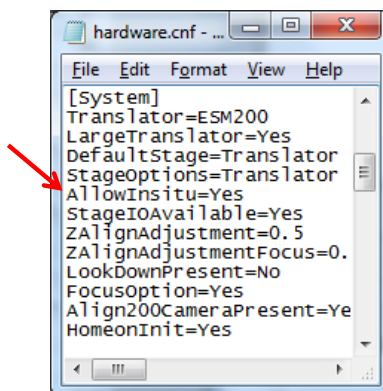


Figure 9-1. Example hardware.cnf file.

1. Select **Hardware>Controls>System>'Activate In Situ Mode'** to start the function. A message will be displayed.

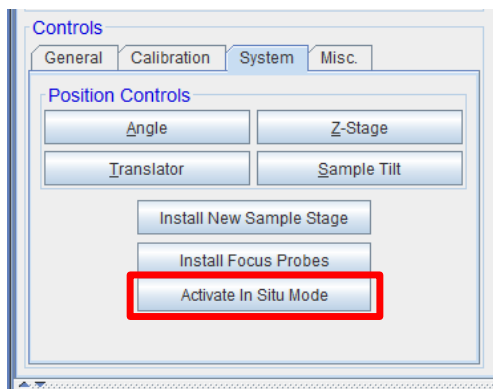


Figure 9-2. Activate In Situ Mode button.

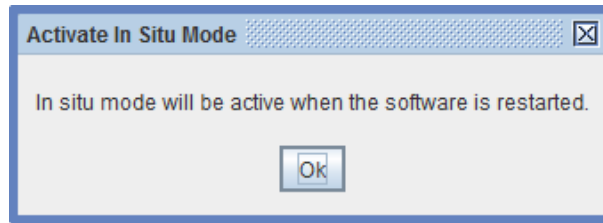


Figure 9-3. Activate In Situ Mode message box.

2. Consult the In Situ Operation Manual to install the system onto the process chamber.
3. If ex situ operation is desired, the 'In Situ Mode' must be deactivated. Select **Hardware>Controls>System>'Deactivate In Situ Mode'** to start the function. A message will be displayed.

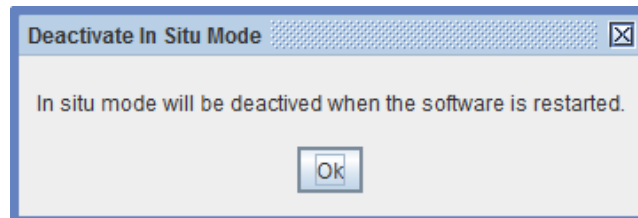


Figure 9-4. Deactivate In Situ Mode message box.

4. The next time the software is started, it will initialize the ex situ base motors (AOI, Z-Stage, etc.) as normal.

10 Scheduled Maintenance

The J.A. Woollam Co. M-2000 ellipsometers are low maintenance instruments. The only required maintenance is to change the lamp(s) as needed and to check the alignment of the system.

10.1 D2 & QTH Lamps (M-2000D, DI, U, & UI) in XLS-200

The lamps must be replaced after a certain period of time. As a lamp approaches the end of its useful life, intensity levels can fluctuate and spectral intensity can be reduced, both may result in poor or noisy data.

LAMP	VENDOR	MODEL#	COLOR TEMP.	RATING	TYPICAL LIFETIME
QTH	ILT	L9404	2900°K	2000 hours	3000 hours
D2	Hamamatsu	L10804	N/A	2000 hours	3000 hours

Table 10-1. Lamps and typical lifetimes.

Lamp Installation/Replacement

1. Turn off the M-2000 Detector and Lamp Power Supply Module. Allow lamp(s) to cool for 2 hours.
2. Remove the (2) M3 SHC screws (2.5mm Allen wrench) and remove the cover on the light source.
3. Put on latex gloves and safety goggles.

Warning: The lamps get extremely hot during operation. Always allow them to cool adequately before replacing.

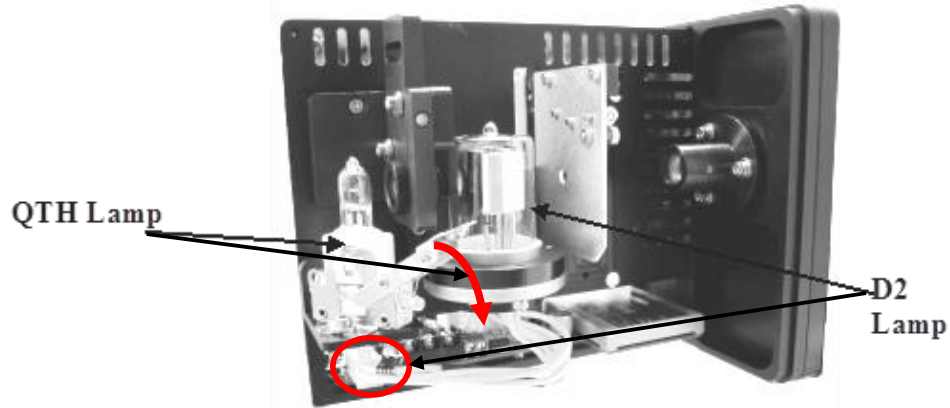


Figure 10-1. Disconnecting the lamps.

4. Disconnect the D2 lamp by unplugging it from the circuit board.
5. Using a 2.5mm Allen wrench, remove the (2) M3 SHC screws under the lamp holding the D2 lamp in place.

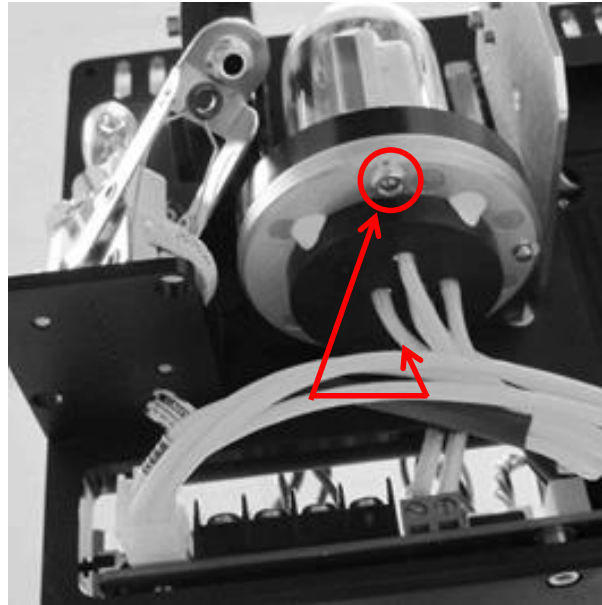


Figure 10-2. M3 SHC screws under D2 lamp.

6. Remove the D2 lamp by sliding out of the mount.
7. To remove the QTH lamp, press the lever slowly down and the QTH lamp will slide up out of its base.

Caution: Do not touch the quartz portion of the lamps. Fingerprints and oils can shorten the life of the lamp. If you do get a fingerprint on the lamp, clean the fingerprint off with alcohol.

8. Place the new D2 lamp in the mount and replace and tighten the (2) M3 SHC screws back into place. Plug the D2 lamp connector back into the circuit board.

9. Insert the new QTH lamp into the holder and ensure it is seated down fully. Note the polarity of the lamp connectors and the base; the lamp will only go in the base one way.
10. Replace the cover.
11. Tighten the SHC screws to lock the cover closed.
12. Reset the hour meter by pressing the reset button located on the front of the M-2000 Detector and Lamp Power Supply Module.

Note: When a new lamp is installed, it must be aligned so that the maximum amount of light is available for sample measurement. The optimal position should not change much from lamp to lamp, but fine adjustment is needed to achieve best results.

Lamp Alignment

After the lamp(s) has been replaced it is recommended that the lamp housing be aligned for maximum intensity. For the XLS-200, no lamp adjustment is necessary.

1. Turn on the lamp power supply. Allow the lamp to warm up for at least 20 minutes.
2. Ensure the Base is in the 90° (straight-through) position and the Z-position is raised such that the sample stage will not block the beam from hitting the receiver unit's aperture.
3. Slightly adjust the source unit tilt stage to center the beam on the receiver aperture if necessary.
4. Open the alignment screen by selecting **Hardware>Controls>General>'Align Sample'**. Choose No when prompted for the full system alignment. If your system has Auto Tip-Tilt, ensure 'Receiver' is selected in the Detector panel at the top of the screen. Verify the cross hair is centered. If not, slightly adjust the receiver unit tilt stage to center the cross hair. See Chapter 4 for more details.

10.2 Xe Lamp (M-2000X, XI, X-210, & XI-210) in FLS-860

This section describes installation/replacement, alignment, and cleaning of the lamps used in the FLS-860 Light Source (for M-2000X, XI, X-210, and XI-210 systems).

The Xenon arc lamp must be replaced after a certain period of time. As a lamp approaches the end of its useful life, power levels can fluctuate and spectral intensity can be reduced, both result in bad or inaccurate data.

LAMP	MODEL #	RATING	TYPICAL LIFETIME
Hamamatsu	L2174-01	1000 hours	1500 hours

Table 10-2. Arc lamp rating and typical lifetime.

Lamp Installation/Replacement

1. Turn off the M-2000 Detector and Lamp Power Supply Module. Allow lamp(s) to cool for 2 hours.
2. Put on latex gloves and safety goggles.
3. Loosen the captive screws (Flat screwdriver) and remove the access panel on the light source.

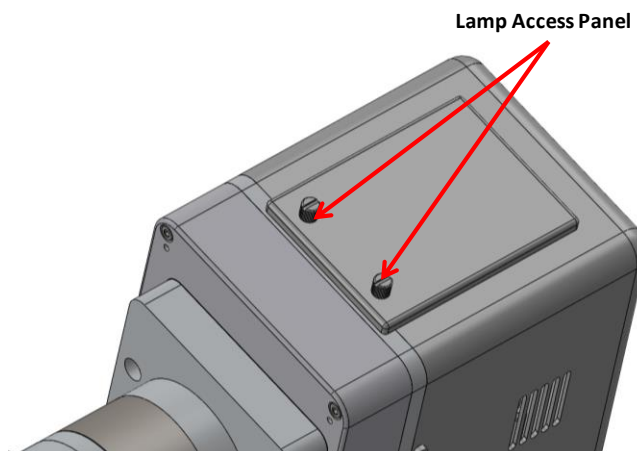


Figure 10-3. Lamp access pane on Light Source.

Warning: Compact arc lamps contain highly pressurized gas, and present an explosion hazard even when cold. Wear face protection, such as a full-face shield, gloves and a long sleeve shirt whenever handling lamps.

4. Loosen the thumb screw and remove the anode holder from the “old lamp”.

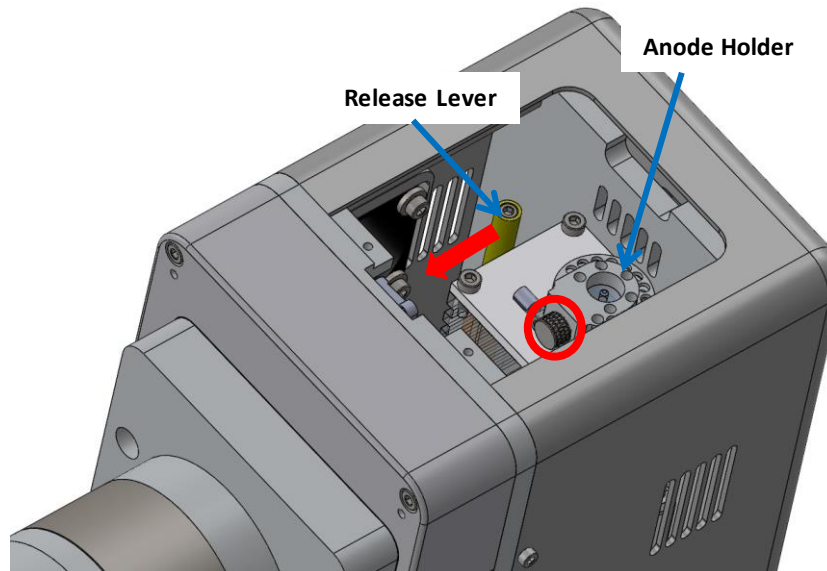


Figure 10-4. Anode holder.

5. Pull the lamp release lever in the direction of the arrow in Figure 10-4, no more than $\frac{1}{2}$ ", and carefully remove the old lamp.
6. Remove the new lamp from its protective packaging, touching only the metal ends of the lamp.

Caution: Do not touch the quartz portion of the lamp. Fingerprints and oils can shorten the life of the lamp. If you do get a fingerprint on the lamp, clean the fingerprint off with alcohol.



Figure 10-5. Typical arc lamp.

7. While pulling the lamp release lever, carefully insert the cathode of the lamp into the cathode holder.
8. The lamp position is very important (see below). The molded point of the glass, which has a wire next to it, should be away from the mirror (back side) in the lamp housing. This is to ensure both that the light is not blocked by the wire and that the molded point (weakest part of the glass) is never positioned "up" as the heat can weaken the glass!!

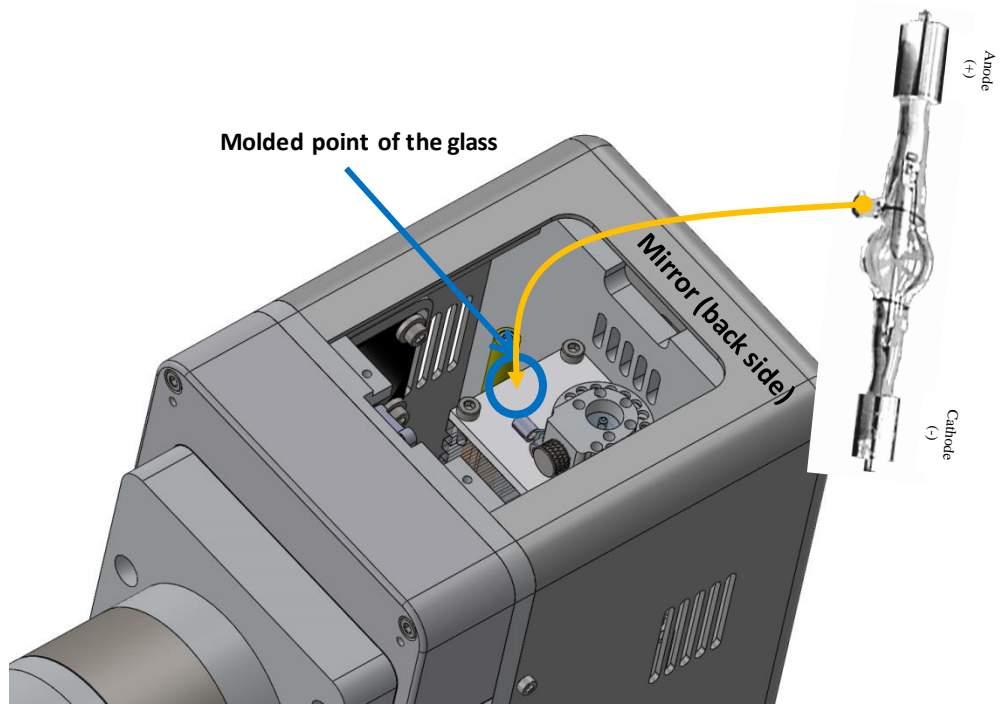


Figure 10-6. Lamp position - for most configurations.

Caution: Depending on the system configuration (Lamp Housing orientation), the lamp may be positioned different. It is important, to ensure lamp life, that it is positioned properly.

9. When the lamp is in position, release the lever and the lamp will be secured.

Note: Ensure the cathode is completely inserted into the cathode clamp and the anode connector is installed in the proper direction.

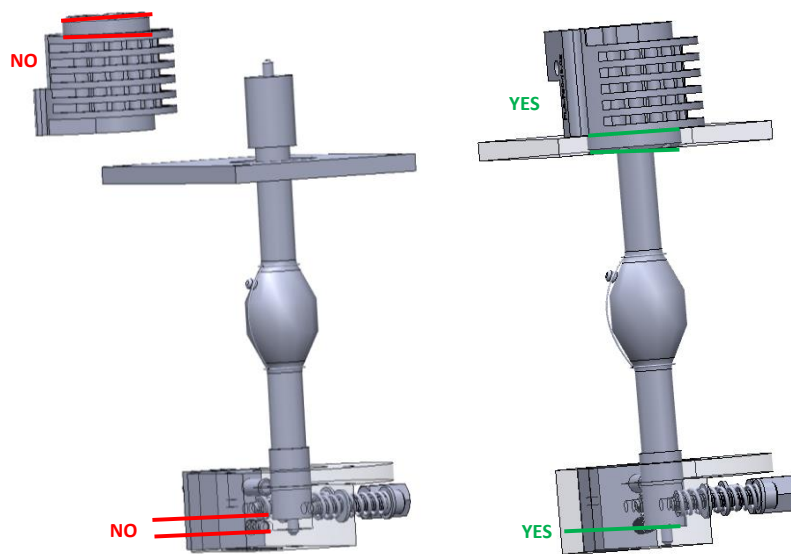


Figure 10-7. Lamp installed.

10. Place the anode holder onto the anode of the lamp, and then tighten the thumb screw.
11. Replace the access panel cover and tighten the captive screws to lock the rear access panel closed.
12. Reset the hour meter by pressing the reset button located on the front of the M-2000 Detector and Lamp Power Supply Module.

Note: When a new lamp is installed, it must be aligned so that the maximum amount of light is available for sample measurement. The optimal position should not change much from lamp to lamp, but fine adjustment is needed to achieve best results.

Lamp Alignment

1. Turn on the lamp power supply and ignite the arc lamp. Allow the lamp to warm up for at least 20 minutes.
2. Ensure the Base is in the 90° (straight-through) position and the Z-position is raised such that the sample stage will not block the beam from hitting the receiver unit's aperture.
3. There are two small adjustment screws located on the back of the light source. These are used to control the position of the reflecting mirror inside the light source.

Mirror Adjustment Access Holes

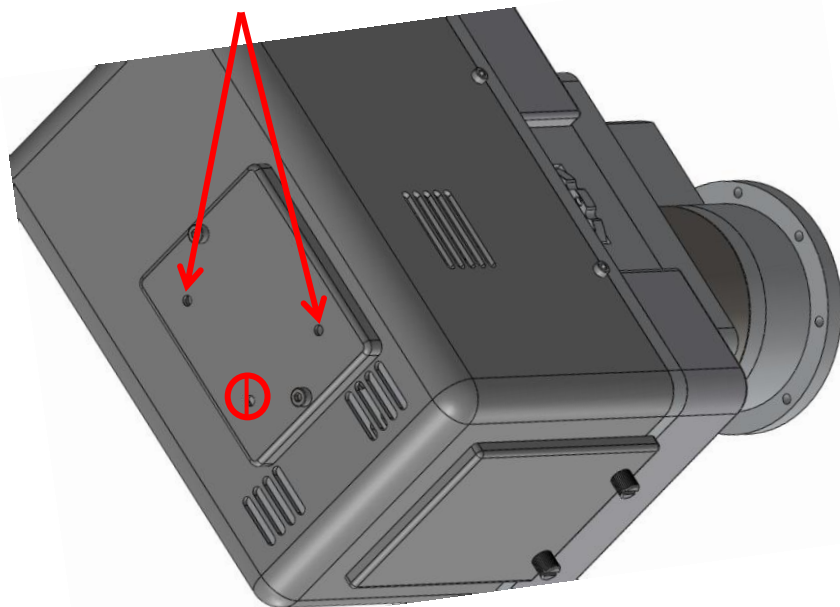


Figure 10-8. Light Source adjustment screws.

Note: Turning off the lights in the room may help facilitate the next few steps.

4. While holding a business card in the path of the beam, adjust the adjustment screws using a 5/64" English Allen (2mm Metric) wrench until the beam is visible (a properly aligned lamp produces a very bright, bluish-white beam).

Note: Only slight adjustment is needed to give the beam a uniform spot on the business card. It may be necessary to iterate between the two adjustment screws for best uniformity and intensity.

5. Once the beam is visually bright, use the ellipsometer to perform the final alignment of the lamp: Open the alignment screen by selecting, **Hardware>Controls>General>'Align Sample'**. Choose No when prompted for the full system alignment. If your system has Auto Tip-Tilt, ensure 'Receiver' is selected in the **Detector** panel at the top of the screen.

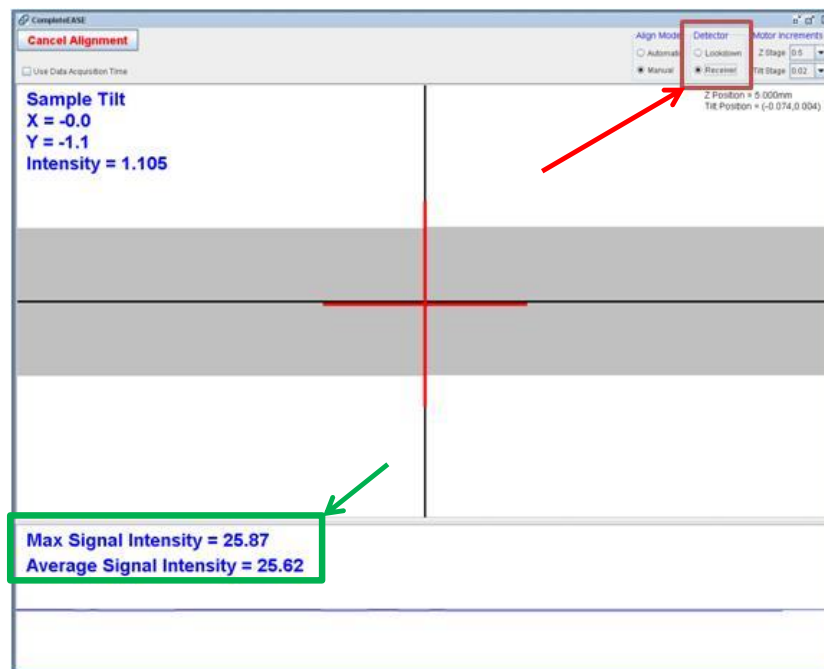


Figure 10-9. Alignment screen.

6. Adjust the lamp adjustment screws to maximize the Average Signal Intensity displayed at the bottom of the Alignment Screen
7. Adjust the Source unit tilt stage slightly so the beam's spot is centered on the receiver unit's aperture.
8. Using the Receiver unit tilt stage, adjust so the cross hair is centered on the alignment screen.

9. Iterate these steps until no further improvement is achieved. The beam should be round and uniform, along with the maximum signal achievement.
10. Verify the System Alignment as described in Chapter 4 of this manual.

Arc Lamp Disposal

Warning: Compact arc lamps contain highly pressurized gas, and present an explosion hazard even when cold. Wear face protection, such as a full-face shield, gloves and a long sleeve shirt whenever handling lamps.

1. Wrap lamp in 10 to 15 layers of paper towels.
2. Insert wrapped lamp in a plastic bag and seal the bag.
3. Wearing personal protective equipment, smash center part of the glass bulb with a hammer.
4. With no pressure, the lamp (wrapped and still in the sealed bag) is safe to dispose.

Mirror Replacement

The reflective mirror can be contaminated over time which could cause loss in signal intensity. This can be monitored by the Ellipsometer and/or visually checked when the lamp is changed. The mirror is low cost and easy to replace if it is suspected to be contaminated.

MIRROR	JAW P/N	DESCRIPTION	TYPICAL LIFETIME
JAW CUSTOM	10408001	CUSTOM PL/CC	3000 hours

Table 10-3. Mirror Part Description.

1. Remove the cover plate from the back of the Lamp Housing.
2. Loosen the screw which mounts the retainer clip. Rotate the retainer clip so that it is no longer contacting the mirror. The mirror is loose fit such that gravity will allow this to “fall out.” An adhesive surface or optical vacuum wand can be used to pull it out.
3. Install the new mirror (reflective side down) and rotate the retainer clip such that it is centered on the back of the mirror. Tighten the retainer clip screw to hold the mirror in place. Check that it is applying enough pressure to hold the mirror stable.

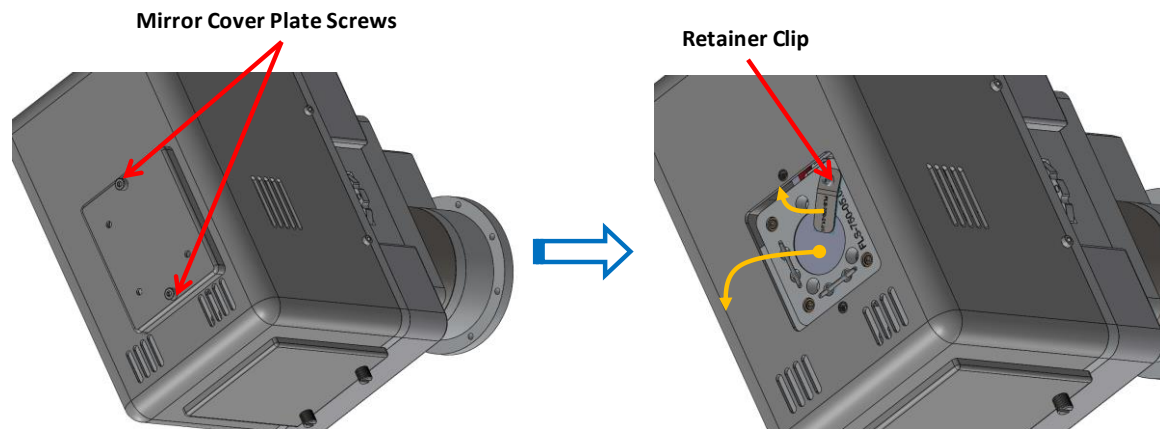


Figure 10-10. Reflective Mirror replacement.

4. Align the mirror using the same instructions from the lamp replacement section above. This can be done at the same time the lamp is changed.

10.3 QTH Lamp (M-2000V & VI) in FQTH-100

This section describes installation/replacement, alignment, and cleaning of the lamp used in the FQTH-100 Light Source (for M-2000V and VI systems).

The QTH lamp must be replaced after a certain period of time. As a lamp approaches the end of its useful life, power levels can fluctuate and spectral intensity can be reduced, both result in bad or inaccurate data.

LAMP	MODEL #	COLOR TEMP.	RATING	TYPICAL LIFETIME
ILT	L7417	3000°K	2000 hours	3000 hours
Oriel	6332	3300°K	50 hours	300 hours

Table 10-4. QTH lamps and typical lifetime.

Lamp Installation/Replacement

1. Turn off the M-2000 Detector and Lamp Power Supply Module. Allow lamp(s) to cool for 2 hours.
2. Put on latex gloves and safety goggles.
3. Remove (2) SHC screws (2.5mm Allen wrench) to remove the cover.

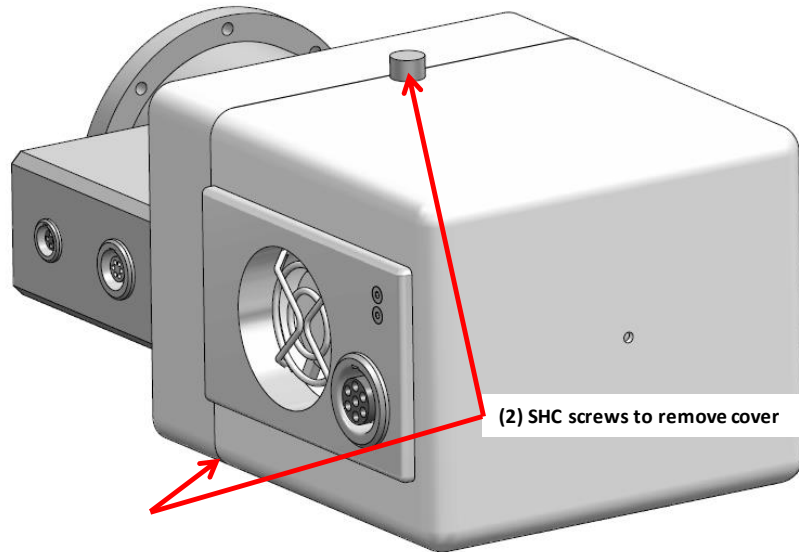


Figure 10-11. Light source cover removal.

Warning: The QTH lamp gets extremely hot during operation. Always allow it to cool adequately before replacing the lamp.

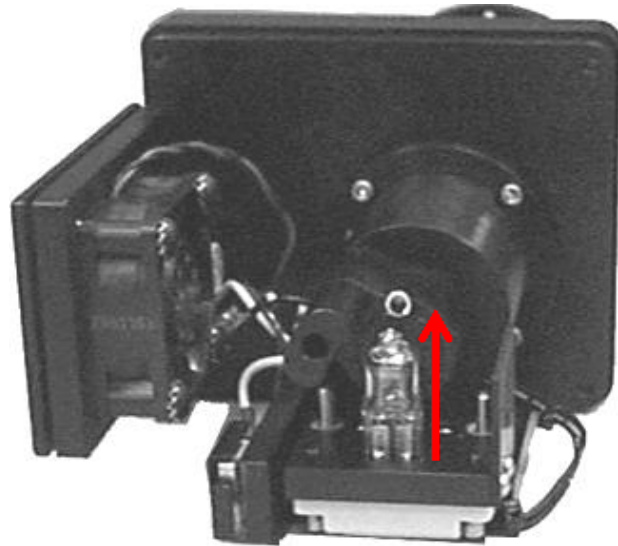


Figure 10-12. QTH mount.

4. While holding the QTH bulb, lift up and pull it out of the socket. A slight side to side rocking motion may facilitate this.
5. Remove the new lamp from its protective packaging.

Caution: Do not touch the quartz portion of the lamp. Fingerprints and oils can shorten the life of the lamp. If you do get a fingerprint on the lamp, clean the fingerprint off with alcohol.



Figure 10-13. Typical QTH lamp.

6. Carefully align the two legs of the lamp into the two holes in the socket. There is no polarity on this lamp.
7. Gently push the bulb down into the socket until it is fully seated.
8. Replace the cover and tighten the SHC screws to lock the cover closed.
9. Reset the hour meter by pressing the reset button located on the front of the M-2000 Detector and Lamp Power Supply Module.

Note: When a new lamp is installed, it must be aligned so that the maximum amount of light is available for sample measurement. The optimal position should not change much from lamp to lamp, but fine adjustment is needed to achieve best results.

Lamp Alignment

1. Turn on the lamp power supply. Allow the lamp to warm up for at least 20 minutes.
2. Ensure the Base is in the 90° (straight-through) position and the Z-position is raised such that the sample stage will not block the beam from hitting the receiver unit's aperture.
3. Select **Hardware>Controls>General>** 'Align Sample'. Choose No when prompted for the full system alignment.
4. Locate the Average Signal reading (bottom of the alignment screen) and make a mental note of the signal value.
5. There is a small adjustment screw located on the bottom of the lamp housing. This screw controls the vertical position of the lamp inside the lamp housing. Using the 1/16" Allen wrench, adjust the screw until the signal reading is maximized.

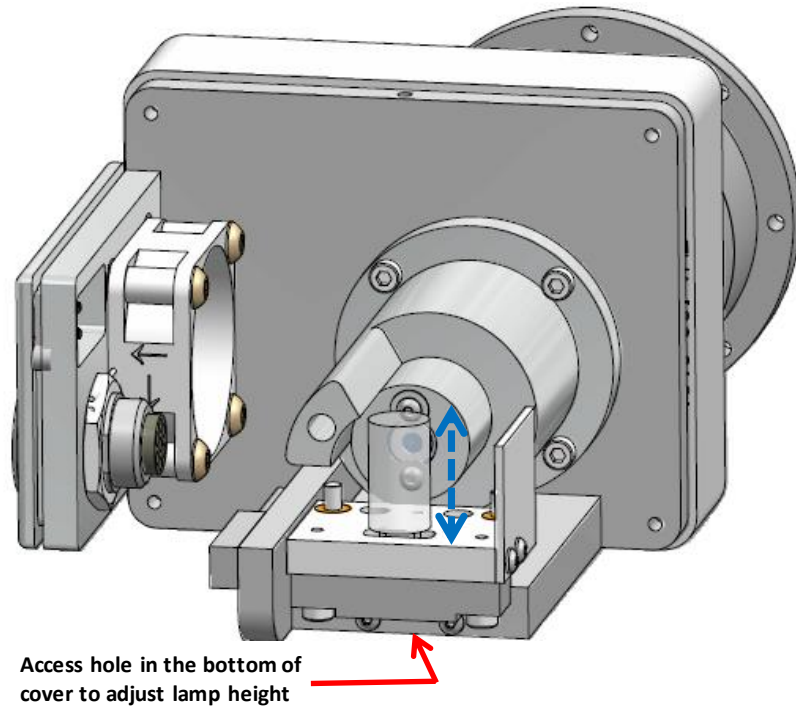


Figure 10-14. Lamp height adjustment.

Note: The adjustment screw shouldn't need to be turned more than one or two turns in either direction. The lamp's position was set at the factory and should be close for most lamps. Only a small adjustment is needed when the lamp has been replaced.

10.4 Optical Fiber

Upon original installation and anytime the optical fibers have been removed, they should be adjusted for maximum light throughput.

This is achieved by slightly loosening the fiber and slowly rotating it while monitoring the Display Signal Screen for maximum intensity. When this is achieved tighten the fiber down. Perform this for each fiber.

Note: Over time the optical fiber may become solarized. If the UV intensity becomes weak, it is recommended to replace the optical fiber.

10.5 Cleaning

The entire system may be cleaned using a soft cloth and mild detergent or isopropyl alcohol. However, only filtered compressed air or "canned air" should be used to remove dust from any of the optical components.

11 Performance Checks

Use the procedures in this chapter to verify that the instrument is operating properly and determine potential problems, if any. The sections below outline verifications/tests in order of increasing complexity. If the first test (Calibration Wafer & Straight-Through Measurement) passes, it is unlikely that any further testing is needed. Similarly, if the second test (System Check) passes, it is unlikely that additional checks are needed.

11.1 Calibration Wafer & Straight-Through Measurement

The quickest way to verify ellipsometer operation is to measure the calibration wafer and take a straight-through measurement of air. A thermal oxide (SiO_2 on Si) calibration wafer is included with every instrument.

To measure the calibration wafer:

1. Follow the Sample Alignment Procedure as described earlier in this manual.
2. Acquire “Standard” Ellipsometry data at a few angles (i.e. 65° , 70° , and 75°).
3. Use the built-in analysis model for Thermal Oxide on Silicon to analyze the data (see CompleteEASE Data Analysis Manual for details).
4. Confirm that a good fit to the data is achieved.

To measure straight-through (air):

1. Select “Measure in Transmission Mode” in the Acquisition Parameters Setup box. A high accuracy, 5 second measurement is recommended.

Acquisition Parameters Setup

Data Acquisition Parameters

Data Type: Standard

Acq. Time: 5 ☒ High Accuracy Mode

Scan Options

Angle Scan: 55.00 To 80.00 By 5.00

☒ Measure In Transmission Mode

Alignment Options

Sample Tilt Alignment: Skip

Sample Height Alignment: Skip

Sample Thickness: 1.068 mm Set To Current Position

☐ Align At First Angle Alignment Angle: 75.00

Other Options

☐ Do Not Return To Sample Load Position

☐ Do Not Reposition Translator

Load Ok Cancel

Figure 11-1. Straight-Through acquisition parameters setup.

2. Evaluate the straight-through measurement. Confirm that Psi and Delta meet the following specifications:

- $\Psi = 45^\circ \pm 0.075$ for 95% of the measured wavelengths
- $\Delta = 0^\circ \pm 0.05$ for 95% of the measured wavelengths

Spectroscopic Ellipsometric (SE) Data

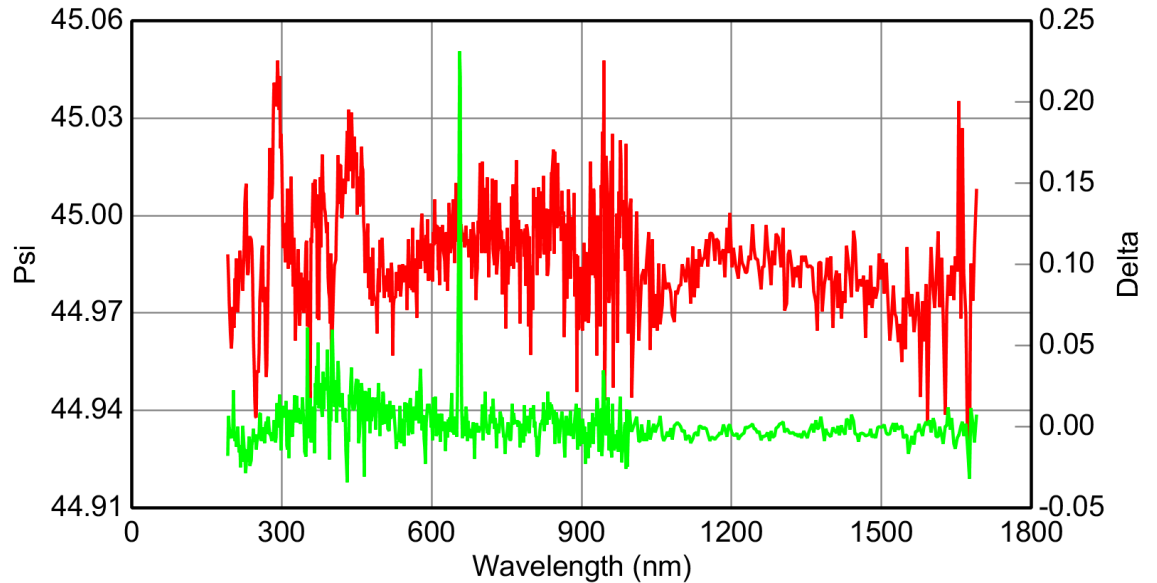


Figure 11-2. Example S-T measurement (M-2000DI).

Successful calibration wafer and straight-through measurement is a strong indicator that the tool is working properly. If the measurement is not successful, a System Check should be performed.

11.2 System Check

A System Check is another easy way to verify that the instrument is operating properly. A System Check can be performed instead of simply measuring the calibration wafer. A System Check should be performed if the calibration wafer or straight-through measurement is unsuccessful.

A System Check executes a quick calibration of the ellipsometer optics and measurement of the calibration wafer. The System Check procedure, and discussion for successful vs. unsuccessful System Check, is described in Section 4.9 of this manual.

Successful System Check is a strong indicator that the tool is working properly.

11.3 Verify Sample Alignment

Proper operation of the instrument relies on proper sample alignment. If the sample is misaligned, measured data (and results) will not be accurate. The Sample Alignment must be performed for each sample that is mounted on the ellipsometer, prior to acquiring data.

Successful Sample Alignment requires that the following conditions are simultaneously satisfied (see Chapter 4 for complete details):

- The tip/tilt of the sample should be aligned such that the sample surface is perpendicular to the plane defined by the optical axes of the source and receiver; alignment screen cross hair should be centered.
- The Z height of the sample should be aligned such that the Receiver Unit is collecting the reflected beam; the beam is centered on the Receiver aperture and intensity is maximized.
- Alignment should be maintained with angle change (the cross hair should not move more than 15 units in X or Y on the Receiver unit Detector).

Note: Reflected intensity is a function of angle; therefore, the intensity will change as angle changes, but the reflected beam should remain centered on Receiver Aperture for all angles.

If these conditions cannot be simultaneously satisfied, the System Alignment should be verified.

11.4 Verify Signal/Lamp Intensity

Intensity can vary from lamp to lamp, and system to system. There are no set intensity cutoff values where the lamp intensity becomes too low for operation. It is good practice to monitor intensity under consistent conditions (i.e. straight-through (90°), or same sample (at same angle) over time. To view intensity, select:

Hardware>Controls>General>'Display Signal'

If experimental Psi and Delta data appear noisy in all or part of the spectrum, the lamp may need to be changed. See rated lifetimes for lamps in Chapter 10 Scheduled Maintenance.

The lamp intensity should not overload the detector. If the 'Display Signal' screen indicates that the detector is overloaded, reduce the intensity by adjusting the iris on the fiber tube (located on Receiver Unit) or the ND Filter Wheel (if available). Detector overloading can be a sample phenomenon. If the ellipsometer is used for highly reflective samples (i.e. metallic substrates) and low reflecting samples (i.e. bare glass), the intensity may need to be adjusted on a sample-by-sample basis.

11.5 Verify System Alignment

Note: A System Alignment should only be performed when the instrument is first delivered, after mounting the Light Source and Receiver components onto a base or chamber, or if the integrity of the alignment is in question.

Note: Alignment of the Light Source and Receiver tilt stages on the base should only be adjusted when the base is in the straight-through (90°) position.

If the previous checks outlined in this chapter are unsuccessful, the System Alignment should be verified. System Alignment is described in Chapter 4 of this manual. If the System Alignment is changed, a System Check MUST be performed when completed to calibrate the ellipsometer optics.

11.6 Angle of Incidence Offset Correction

This function can be used to correct the systematic offset from the nominal angle values of the opto-mechanical system.

Note: This function should not be performed if there is any question in the integrity of the System Alignment.

1. Mount and align the 25nm SiO₂/Si calibration sample.
2. Select **Hardware**>**Controls**>**Misc.**>'Additional Hardware Functions.' This will bring up a message box. Select 'Angle Offset Correction.'

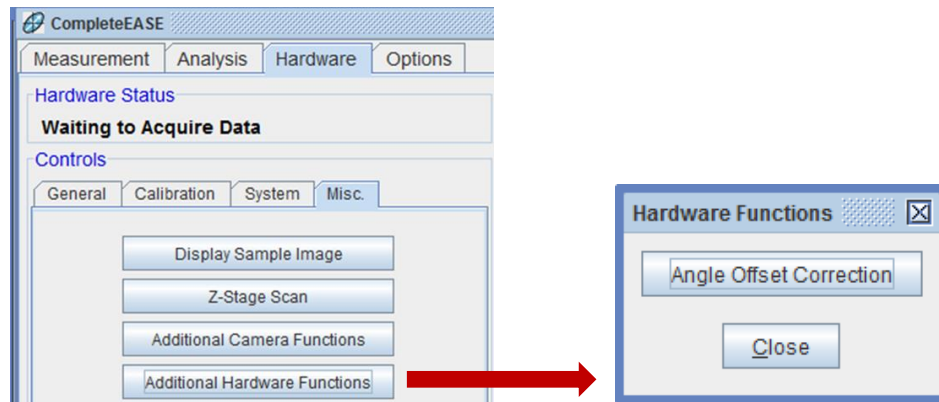


Figure 11-3. Additional Hardware Functions.

During the process, the system acquires data at angles from 45° to 85° every 10 degrees. After the measurement, the system will automatically update the hardware.cnf file with the new offset values.

This correction may also be done with the Focusing Optics attached (if available). The AOI range will be set based on the allowed range. The angle corrections are separate from the unfocused corrections, so will not affect the AOI when the Focusing Optics are removed.

11.7 System Calibration

A System Calibration is performed when the wavelengths of the instrument are known to be incorrect or the compensator or spectrometer has been changed. These situations occur if the M-2000 box or light source has been replaced. This document describes the System Calibration procedure for determining the wavelengths and compensator calibration coefficients.

Note: DO NOT attempt this procedure unless instructed to do so by a representative of J.A. Woollam Co.

Overview

Performing a System Calibration involves iterating between two steps - the System calibration and the Wavelength calibration. The first step measures the positions of the optical elements and the Retardance of the compensator at the currently accepted wavelengths. The second step measures a wavelength correction by acquiring data on three known samples and fitting the data to a model assuming the wavelengths are not known exactly. The first step is then repeated using the newly measured wavelength correction.

Note: Before starting the calibration, make sure that the 2nm, 10nm, 25nm, and 1000nm oxide samples are available. Certain systems will also require the 60nm oxide sample.

System Calibration

Note: The System Alignment and Sample Alignment must be correct and understood by the user before ever attempting a System Calibration. If done incorrectly, the system may not be functional. The System Calibration will not fix any hardware problems. If these problems exist, fix them first before performing a System Calibration.

1. Load the Factory Setup model from the Calibration Wafers folder located in the CompleteEASE\Library folder.

Note: Only the System Calibration and Wavelength Calibration sections will be used. The other sections are used for initial setup of the Ellipsometer at the factory.

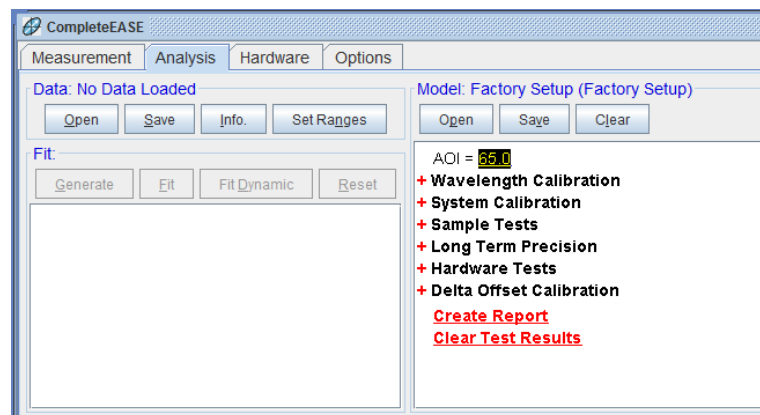


Figure 11-4. Factory Setup model loaded in the Model panel.

2. Verify System Calibration Settings - View the settings for the System Calibration by expanding **System Calibration** section. These settings are

dependent on the base type and the wavelength range of the instrument. If the settings are incorrect, change them in the hardware configuration dialog which can be accessed by choosing 'Edit Hardware Config.' from the **Hardware** tab.

AOI = [65.0](#)
+ **Wavelength Calibration**
■ **System Calibration**
Settings From Hardware Configuration:
Sample #1 = 25nm Oxide on Si
Sample #2 = 10nm Oxide on Si
Sample #3 = <Straight-Through>
Cal. Mode = 3
Acquisition Time = 2.0
[Perform System Calibration](#)
+ **Sample Tests**
+ **Long Term Precision**
+ **Hardware Tests**
+ **Delta Offset Calibration**
[Create Report](#)
[Clear Test Results](#)

Figure 11-5. Example of configuration settings for a multi-angle system.

3. Press [Perform System Calibration](#) and follow instructions to complete the System Calibration. If asked about performing a full sample alignment, choose Yes and enter a sample thickness of 0.55mm for the calibration wafer.

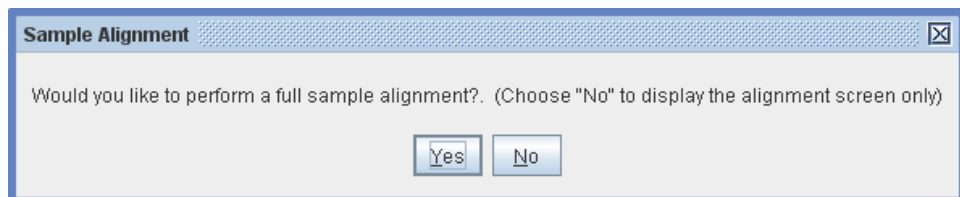


Figure 11-6. Choose Yes to perform a full sample alignment.

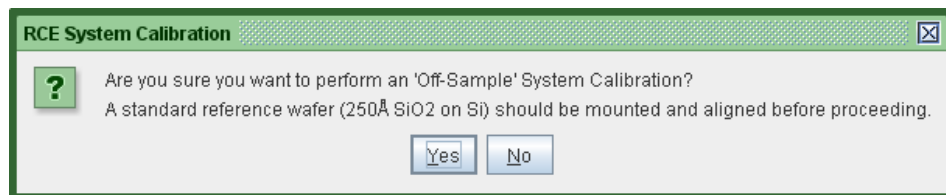


Figure 11-7. Last chance to opt out of system calibration.

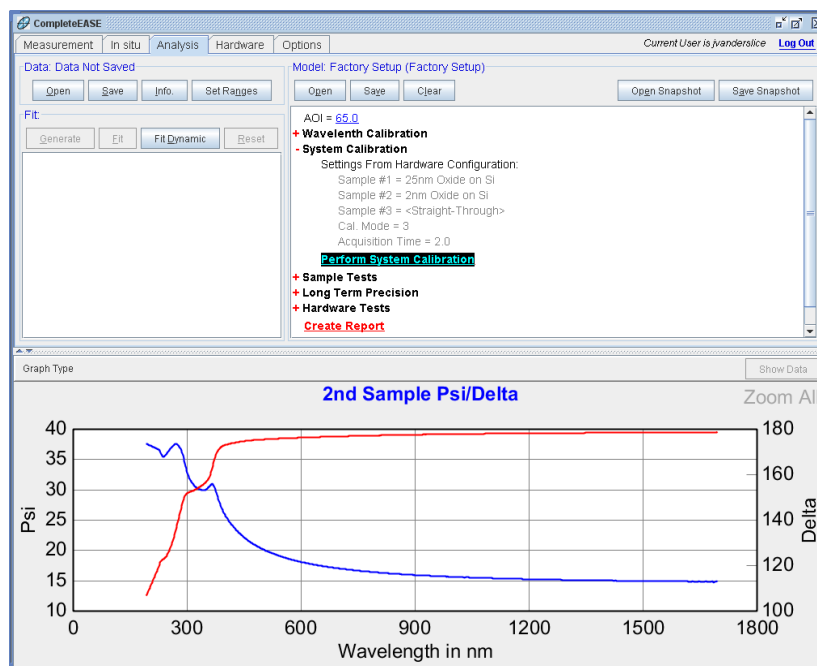


Figure 11-8. Calibration finished.

4. The system calibration is finished when the graph title shows “2nd Sample Psi/Delta”.

System Calibration with ND filter wheel option

When performing the system calibration using a filter wheel, there are some factors to consider. Since the straight-through position is included in the calibration, the signal needs to be optimized throughout the entire spectrum. If a higher density filter is selected, the DUV signal is lower with respect to the overall average signal. As seen below, if a lower density filter is selected and the iris(es) or filter position on the Receiver unit is closed down to avoid ‘Overload’, the DUV signal is optimized. This results in a much better calibration result at these lower wavelengths.

Examples of filter wheel positions vs. Signal Intensity:

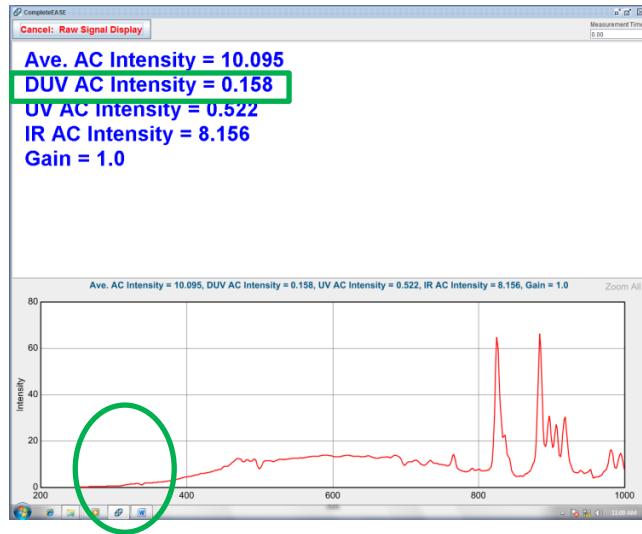


Figure 11-9. Filter 6 with iris open.

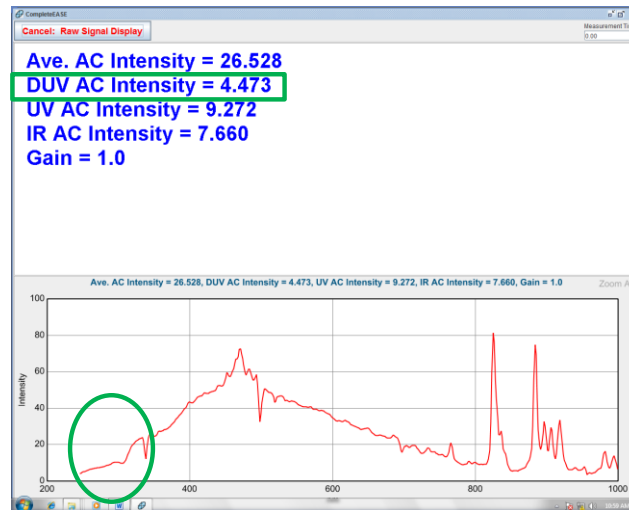


Figure 11-10. Filter 4 with iris closed to avoid overloading the spectrometer.

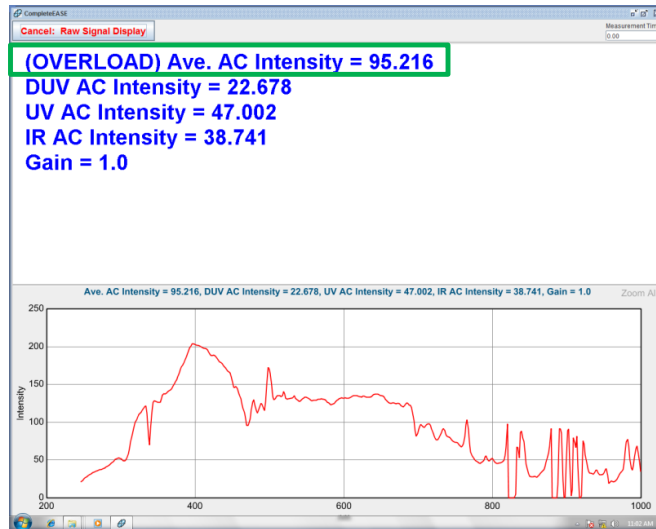


Figure 11-11. Overloaded spectrometer.

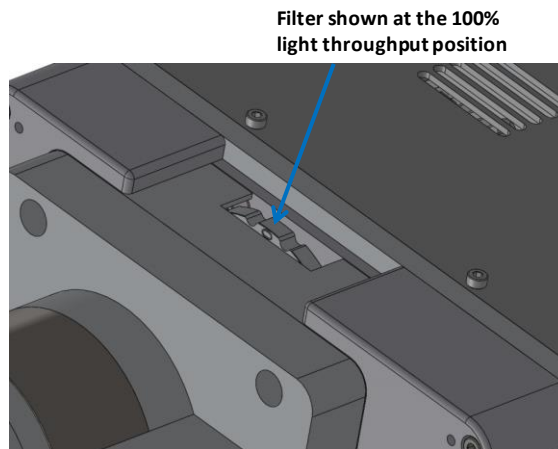


Figure 11-12. Source unit filter wheel option.

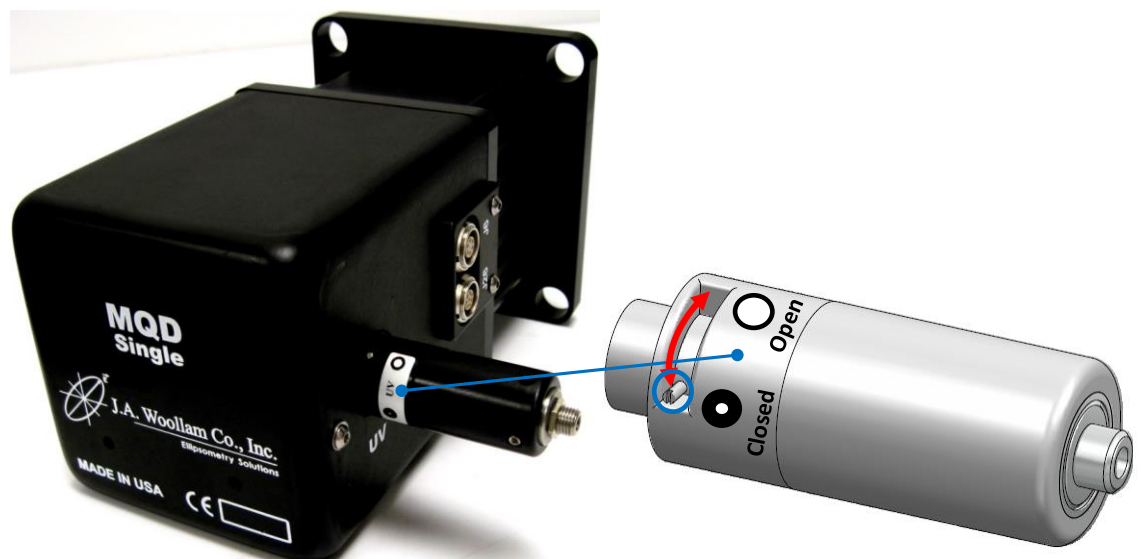


Figure 11-13. MQD-Single Receiver unit iris operation.

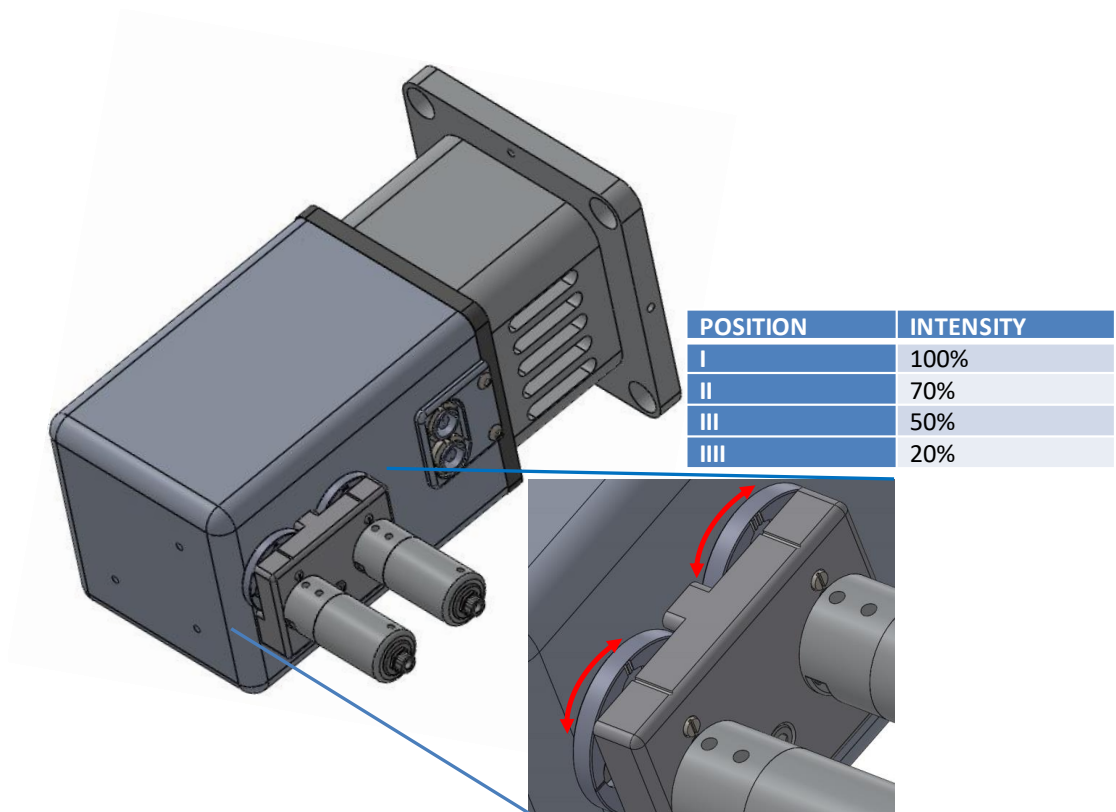


Figure 11-14. MQD-Dual filter wheel selection.

Wavelength Calibration

1. Expand **Wavelength Calibration** section – do not change items in **Wvl Cal Model** section unless given instructions to do so.

AOI = [65.0](#)

Wavelength Calibration

2nd AOI = [75.0](#)

Acq. Time = [4.00](#)

+ Wvl Cal Model

[Perform Wavelength Calibration](#)

+ System Calibration

+ Sample Tests

+ Long Term Precision

+ Hardware Tests

+ Delta Offset Calibration

[Create Report](#)

[Clear Test Results](#)

Figure 11-15. Wavelength calibration model.

2. Press [Perform Wavelength Calibration](#) and follow the instructions. When the process is completed successfully, you will be asked if you want to write the wavelength correction values to the hardware.cnf file,

choose 'Yes.' A System Calibration must be performed again after the software finishes reinitializing the system.

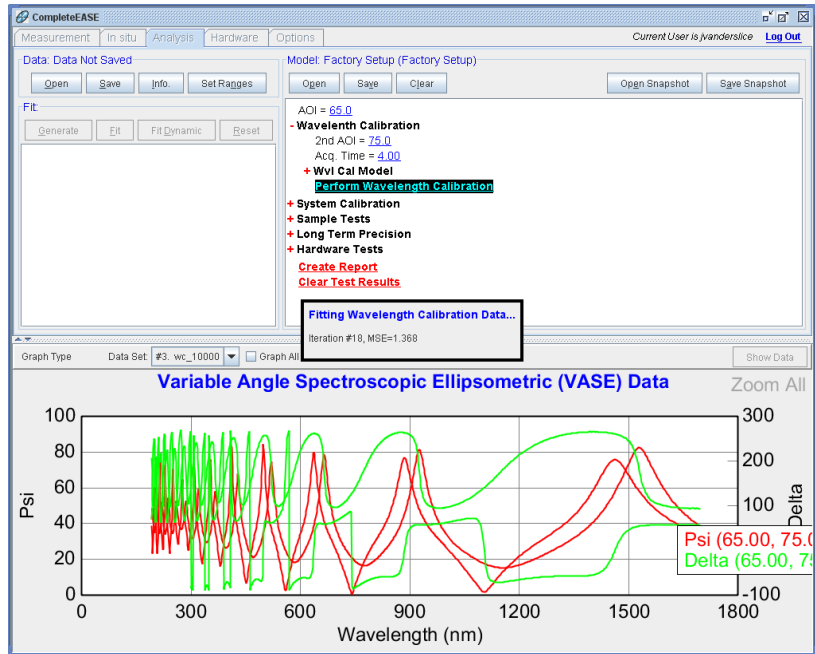


Figure 11-16. Performing wavelength calibration.

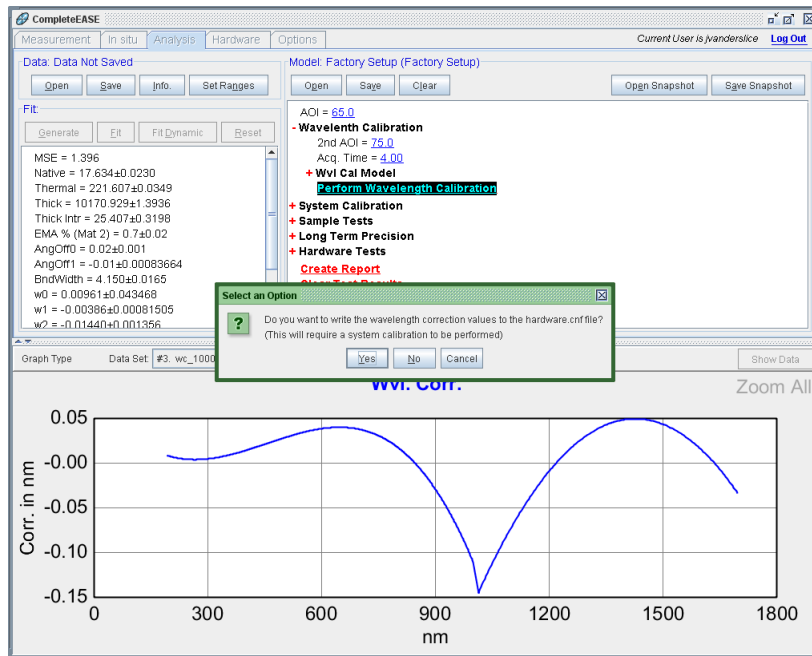


Figure 11-17. Wavelength calibration was successful.

12 Troubleshooting

12.1 General Procedures

Check for the following LED indicators on the system components:



Figure 12-1. Spectrometer power LED.



Figure 12-2. EC Module power LEDs.

Debug File

To facilitate a quicker response, start by sending a debug file along with a detailed description of the problem and any related symptoms and error messages.

Select **Options>About CompleteEASE>Create Debug File** to create a debug file. The file created is located in C:\CompleteEASE\CompleteEASE_Debug.zip.

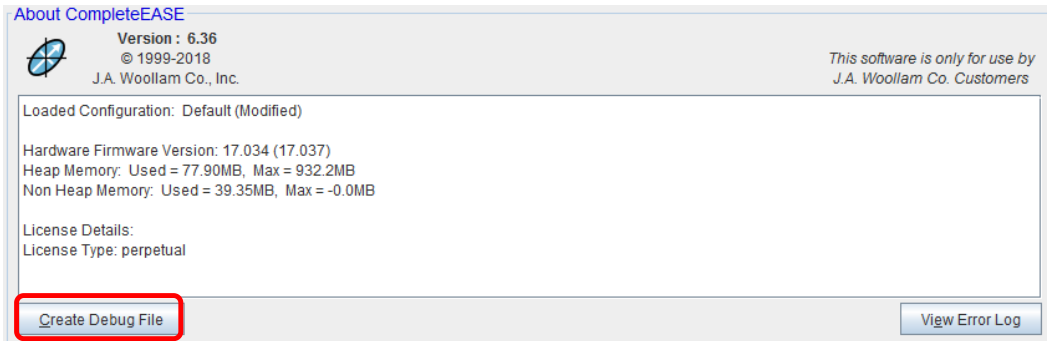


Figure 12-3. CompleteEASE options tab.

12.2 Common Screen Error Messages

Phase Sensor Error Message

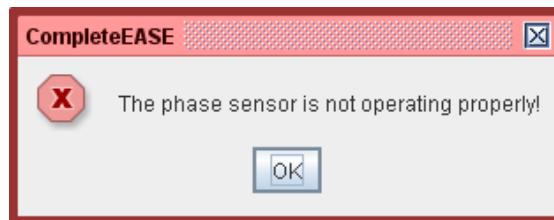


Figure 12-4. Phase sensor error message.

This message is generally caused by one of the following:

1. RCE motor (Source side motor) is not running
2. Phase sensor malfunctions inside the Source motor control module has electronic problems (motor driver, etc.)
3. Electrical connections between J1 and J2 or J3 and J4 are not secured – check the cable connections and that the pins on the connectors all look normal.

User key points: Is the Source side motor spinning (vibrating) to the touch?

Polarizer Homing Error Message

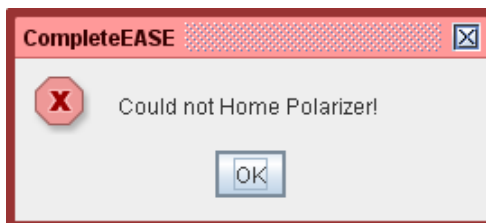


Figure 12-5. Polarizer home error message.

This message indicates that the analyzer's home sensor is not working. Possible causes are:

1. Sensor malfunctions inside the Receiver side motor
2. Electrical connection (cable) between J26 and J25 – check the cable connections and that the pins on the connectors all look normal.
3. Power to the analyzer motor is not delivered / electrical connection between J6 and J5 – examine the connectors and reconnect the cable.
4. EC control module has electronic problems (motor driver, etc.).

User key points: Listen/feel – Is the Receiver side motor turning?

Spectrometer Is Not Scanning

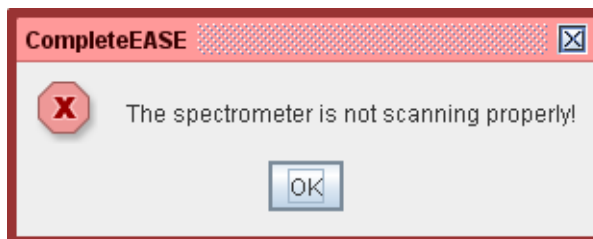


Figure 12-6. Spectrometer error message.

Examine the cables and cable connections at J7 and J8, J9 and J10, and J11 and J12. The cable connects J7 and J8 is the spectrometer power cable. J9 and J10, J11 and J12 are spectrometer digital line cables with color code. Be sure to connect them correctly.

User key points: Is the spectrometer power LED ON? – located on the front of the M-2000 detector box.

Communication Problems

If the software will not communicate with the system (EC), the following parameters need to be investigated. The software will NOT give an error message, it simply will not initialize because the TCP/IP link cannot be

established. This can be verified by viewing the log file (**Options>About CompleteEASE>'View Error Log'**).

Example:

2009-6-23 [12:52:24] - initSocket Error, Connection timed out: connect

Compare the IP address displayed in the error message box with the one displayed on the LCD on the EC front panel. If they are different, correct one displayed on the EC to match the other one by following the procedures described in Section 3.2 Electronics Control (EC) Module Setup.

- If there are two network cards in the operator's computer, make sure that the other network card has a different IP address than the one used for the ellipsometer.
- Check the IP settings on the network card for ellipsometer in the operator's computer as described in Section 3.3 Operator Computer Setup.

12.3 General Problems

SYMPTOM	CAUSE	SOLUTION
The cross hair on the alignment screen jumps around during System Alignment or Sample Alignment	Misalignment	Perform System Alignment or Sample Alignment procedures described in this manual. The cross hair becomes stable only if there is signal. If there is no light hitting the detector, the cross hair will be jumpy. Therefore, when performing the alignment, the first step is to make sure there is light hitting one or more of the four quadrants by looking at the intensity (grey area) on the screen. Ignore the cross hair position until all 4 quadrants receive some amount of the light.
	No white light	Check lamp and light problems chart.
One or more motors do not turn.	Loose connection	Check all cable connections.
	Blown fuse	Check fuses on the EC.
	Bad Motor Driver in EC	Check/Replace Driver. This can be verified by looking at the drivers to see if there are red LEDs next to drivers. If so, the driver may be defective.
Alignment not sensitive to the sample tilt.	The sample is not properly aligned	Re-align the sample, ensuring that the beam is centered on the aperture of the receiver unit. Use of optional Focusing attachment reduces sensitivity to sample tilt.

Table 12-1. General problems.

12.4 Software Problems and Error Messages

SYMPTOM	CAUSE	SOLUTION
CompleteEASE does not initialize.	Cables are not plugged into computer or EC.	Ensure all cables are inserted and fastened.
	Recent hardware changes to computer such as a network card.	Remove recent additions to computer. Then, correct hardware settings of new cards such that they don't conflict.

Table 12-2. Software problems and error messages.

12.5 Calibration Problems

SYMPTOM	CAUSE	SOLUTION
Calibration fits are not acceptable.	Sample is not aligned properly.	Re-align the sample.
	Signal intensity is weak on some channels due to sample reflection properties. Detector(s) Overloaded.	Use the standard SiO ₂ on Si reference sample supplied with the instrument for calibration. Close the respective iris or choose a higher density ND filter (if equipped).
Software installed on a new computer, and results are not correct.	Calibration files not installed on the new computer	Copy cnf files from the previous computer into the C:\CompleteEASE\cnf directory of the new computer

Table 12-3. Calibration problems.

12.6 Signal Screen Problems

SYMPTOM	CAUSE	SOLUTION
Signal screen shows flat lines on all channels.	Cables not connected properly. Electronic scanning problems.	Make proper cable connections. Call J.A. Woollam Co. for instructions.

Table 12-4. Signal screen problems.

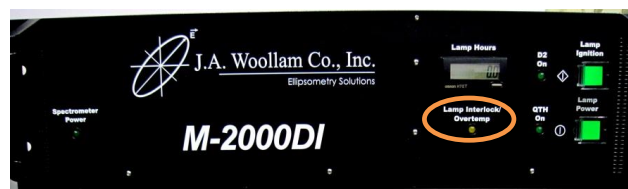
12.7 Lamp and Light Problems

SYMPTOM	CAUSE	SOLUTION
No White Light from the light source	Lamp is not on	Turn on lamp power supply.
	Lamp power supply failed	Call J.A. Woollam Co. to obtain the trouble shooting guide for the power supply.
	Lamp is out of alignment	Align lamp.
Lamp intensity fluctuates or is weak.	Lamp is out of alignment	Align lamp.
	Lamp may be mounted loosely in housing or expired.	Check lamp mount (after power off and cool down for 1hr) or replace lamp.

Table 12-5. Lamp and light problems.

M-2000DI/UI

'Lamp Interlock/Overtemp' indicates that the lamp housing cover is not installed completely and/or the lamp power cable is not connected and/or the temp. sensor has tripped (likely cooling fan issue)



M-2000XI

'Lamp Door' indicates the lamp access door and/or mirror access panel is not latched and/or the temp. sensor has tripped and/or the lamp power cable is not connected.

'Overtemp' indicates that the lamp power supply inside the M-2000 temp. sensor has tripped (likely cooling fan issue).

The LED status is "latching" so power must be reset to change the state



M-2000VI

The Lamp Power switch LED will indicate if the lamp is ON. If not, the AC power, lamp power cable, or lamp housing cover is not present.



Table 12-6. M-2000 Lamp Indicator LEDs.

12.8 USB Camera

The USB Camera(s) must be connected and have the correct driver assigned in order to operate properly. Windows Device Manager is an easy tool to confirm it is connected and operating properly.

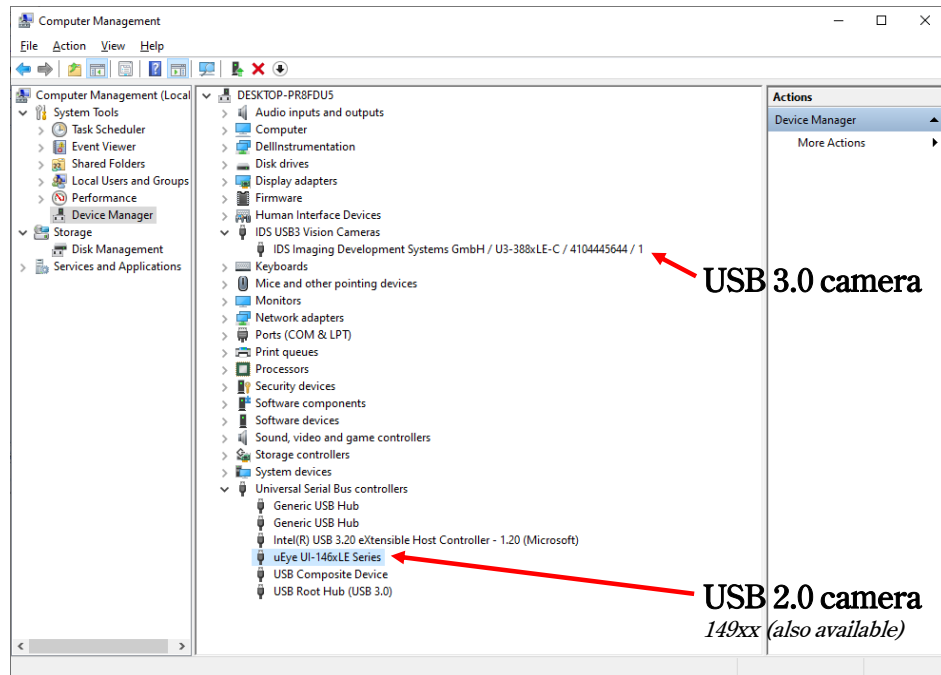


Figure 12-7. Windows Device Manager.

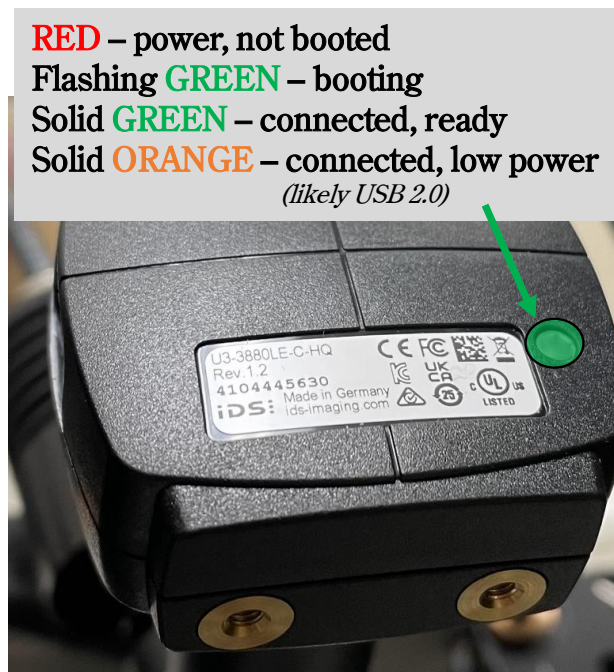


Figure 12-8. USB 3.0 Imaging Camera Status.

13 Specifications

Exact specifications may vary depending on configuration. These details along with schematic documentation are available upon request. Below are the most commonly used components

13.1 Components

All AC Mains components are European Type approved, CE marked and UL listed

All AC Mains components are connected with 600V rated wire and insulated terminals

All PCBs and components are RoHS Compliant

Electronics Control (EC) Module

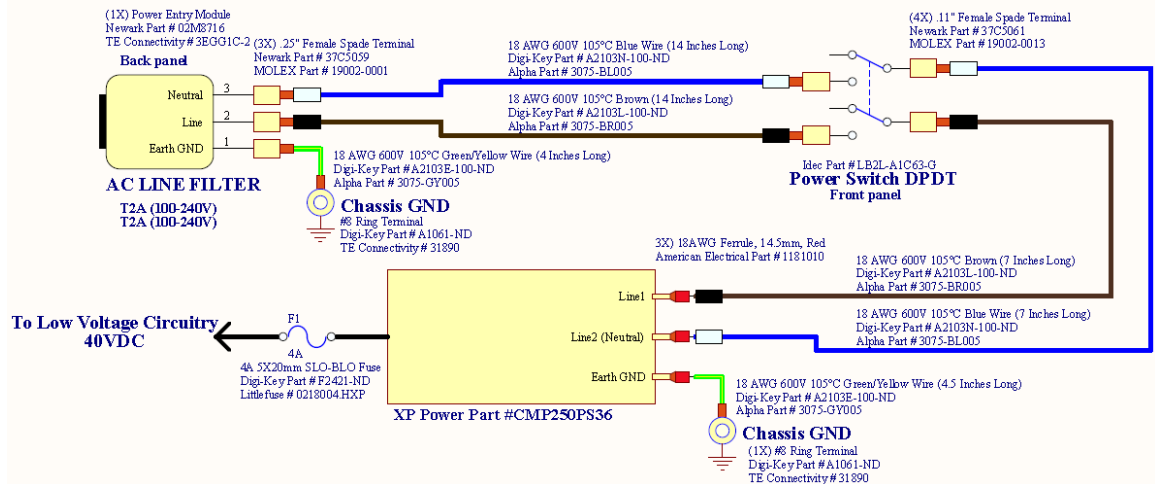
Input Voltage: 100/115/230/240VAC.

Frequency: 50-60Hz.

Current: 1A1A/.4A/.4A.

Fuses: (2) T2/T2A.

Line/Neutral fused in Power Entry Module



Detector / Lamp Power Supply Modules

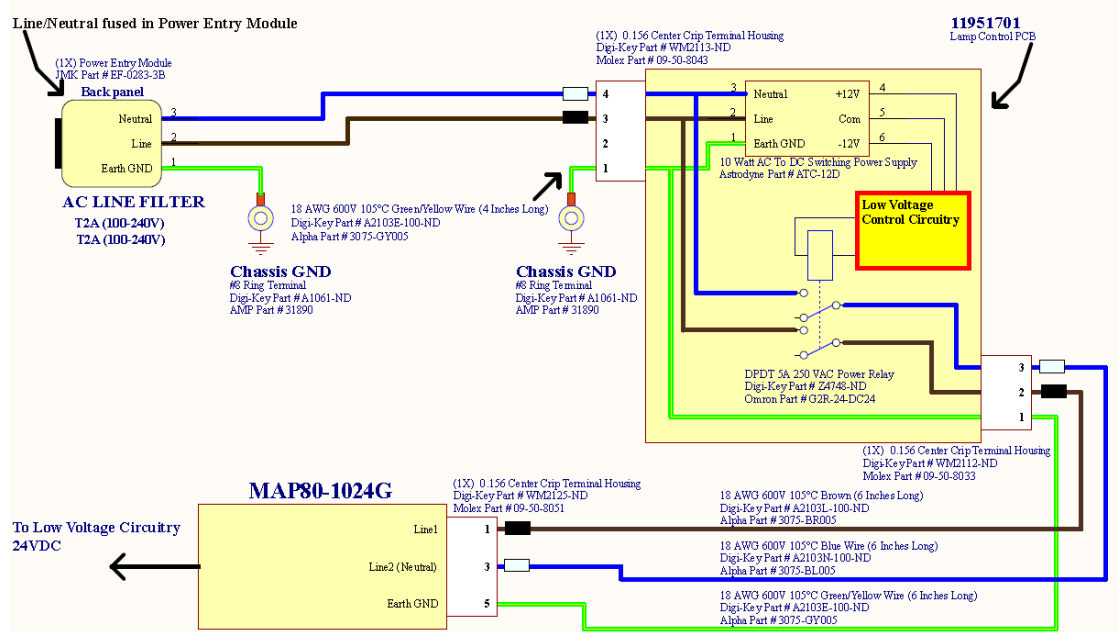
Input Voltage: 100/115/230/240VAC.

Frequency: 50-60Hz.

Current: 1.2A/1.2A/0.6A/0.6A.

Fuses: (2) T2A/T2A.

M-2000D(I), M-2000U(I)



Line/Neutral fused in Power Entry Module

(1X) Power Entry Module
JMK Part # EF-0283-3B

Back panel

Line 3
Neutral 2
Earth GND 1

AC LINE FILTER
T2A (100-240V)
T2B (100-240V)

18 AWG 600V 105°C Green/Yellow Wire (4 Inches Long)
Digi-Key Part # A2103E-100-ND
Alpha Part # 3075-GY005

Chassis GND
#8 Ring Terminal
Digi-Key Part # A1061-ND
TE Connectivity # 31890

(1X) 0.156 Center Crip Terminal Housing
Digi-Key Part # WM2125-ND
Molex part # 09-50-8051

Line +12V 4
Neutral Com 5
Earth GND -12V 6

10 Watt AC To DC Switching Power Supply
Allied Electronics Part # 800-1925
Coelec Part # YAW1012E

Low Voltage Control Circuitry

DPDT 8A 250 VAC Power Relay
Digi-Key Part # 255-1600-ND
Panasonic Part # DK2A-24V

(1X) 0.156 Center Crip Terminal Housing
Digi-Key Part # WM2112-ND
Molex part # 09-50-8033

Hamamatsu C11522-00-54
Hamamatsu P/N C11522-00-54

CN1 (Neutral)
CN1 (Line)

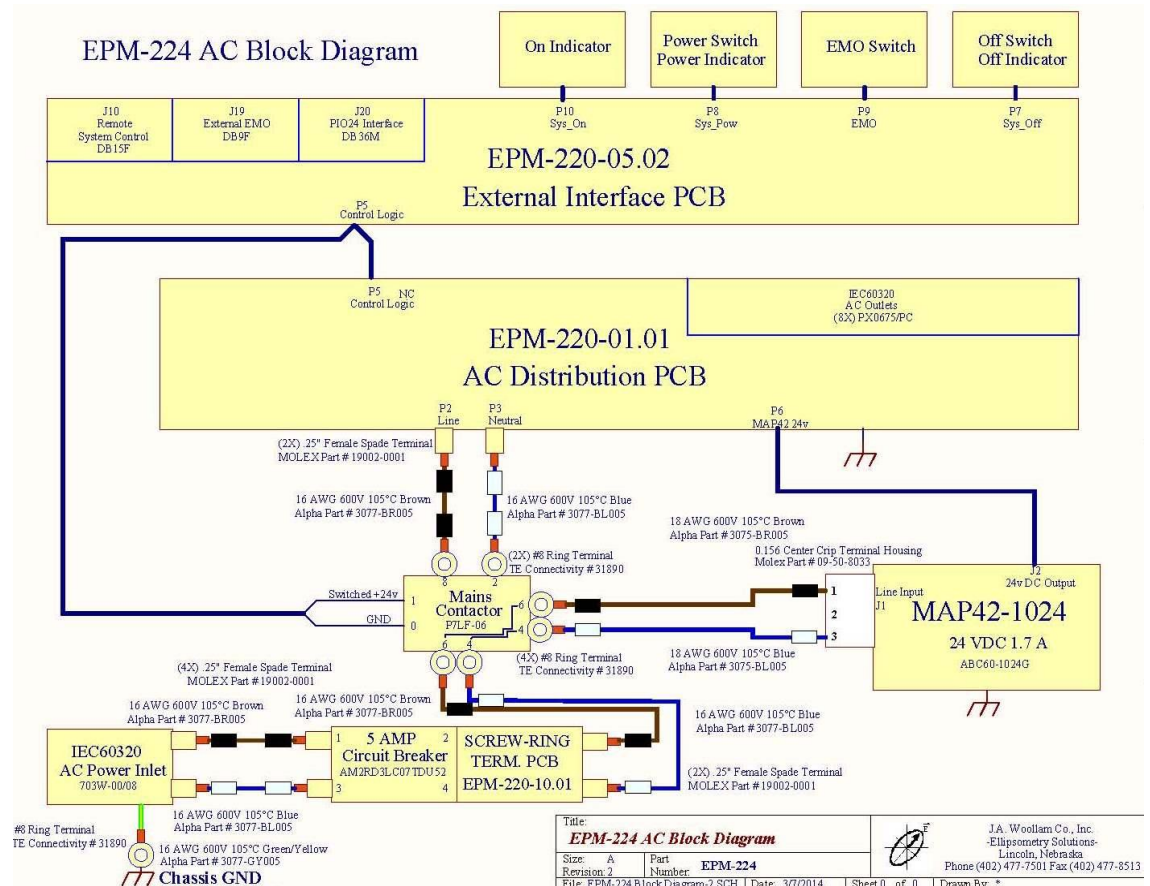
(2X) JST Contact # SVH-21T-PL-I
(1X) JST Housing # VNR-3N

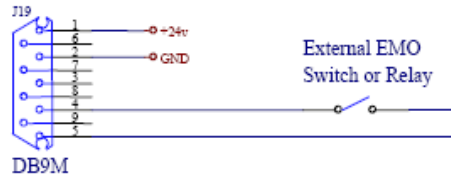
18 AWG 600V 105°C Brown Wire (13 Inches Long)
Digi-Key Part # A2103L-100-ND
Alpha Part # 3075-BR005

18 AWG 600V 105°C Blue Wire (13 Inches Long)
Digi-Key Part # A2103N-100-ND
Alpha Part # 3075-BL005

SSB-600-07.04
Lamp Control PCB

Circuit Breaker: UL489, 5A. (10A for EPM-221)





Pin 1: Fused +24 volts from internal power supply. Always on. 1/2 amp capacity.
 Pin 2: Ground
 Pin 3: No Connection
 Pin 4: EMO circuit
 Pin 5: EMO circuit
 Pins 6-9: No Connection

Power and ground are provided to power potential interface circuitry. 1/2 amp maximum draw.

Opening switch or relay connected to pins 4 and 5 will activate EMO, shutting down AC power.

For the External EMO to be functional, an internal jumper located next to the EMO Interface connector must be in the 'Enable' position.

Title		
EPM-220 Series External EMO Interfa		
Size	Number	Revision
A		
Date:	22-May-2003	Sheet of

Surge Suppressor

Supplied by manufacturer.

Computer

Supplied by manufacturer.

Monitor

Supplied by manufacturer.

13.2 Environmental Operating Range

- Temperature: 10°C to 35°C
- Humidity: 20% to 80% (non-condensing)