

2.2. Facilities Requirements

Facilities requirements for the alpha-SE system are listed in Table 2-1 and the system dimensions are given in Figure 2-1. As shown in Figure 2-2, the preferred clear work area is 20 by 18 inches (500 by 460 mm), excluding the operator computer.

Table 2-1. Facilities requirements for the alpha-SE system.

SPECIFICATION	ALPHA-SE REQUIREMENT
Power	<u>alpha-SE</u> 100-240 VAC \ 1 Amp \ 47-63 Hz. \ IEC320 receptacle <u>vacuum pump</u> 100-120 VAC \ 1Amp \ 47-63 Hz. or 200-240 VAC \ 0.5 Amp \ 47-63 Hz.
Weight	39 pounds (18 kilograms) <i>*ensure work surface will support alpha-SE*</i>
Computer	<ul style="list-style-type: none"> Windows 98 or higher, USB port version 1.1 or higher Within 10 ft. (3 m.) of the alpha-SE ellipsometer

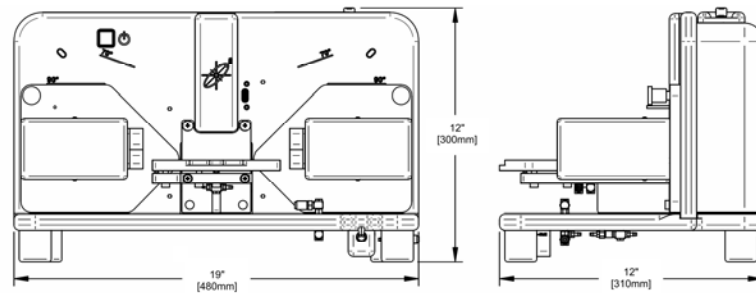


Figure 2-1. alpha-SE dimensions.

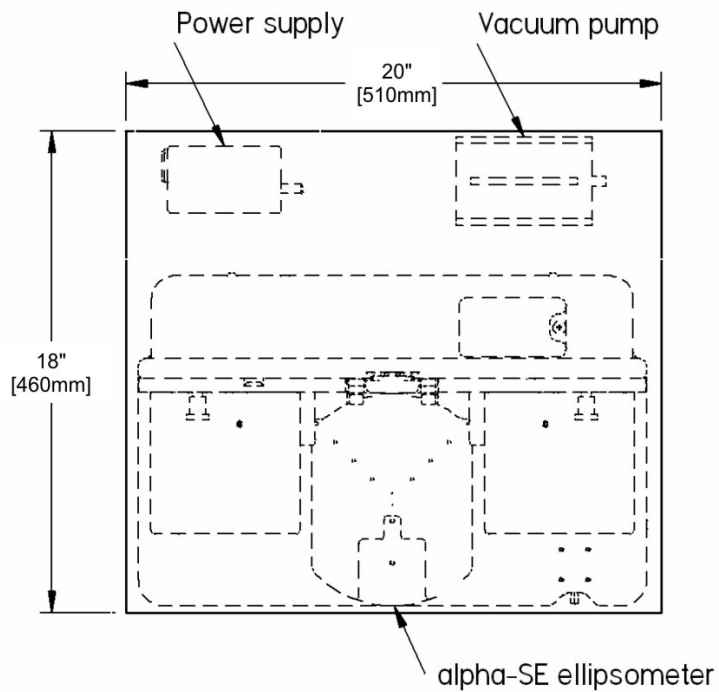


Figure 2-2. alpha-SE workspace for installation.

2.3. Unpacking the Hardware

Opening the Shipping Container

Move the alpha-SE shipping container to the area where the tool will be installed. Open the container and remove the top and side pieces of packing foam. Carefully remove all smaller components from the shipping container, verifying that you received all components, as shown in Figure 2-3. Finally, remove the alpha-SE ellipsometer and position it on your clear 20" by 18" (510 by 460 mm) workspace. The alpha-SE should only be lifted by its handles as shown in Figure 2-3.

Caution: The alpha-SE ellipsometer without sample chuck weighs approximately 37 lbs. (16 kg.). Please find an assistant to lift the alpha-SE unit out of the shipping carton and on to clear work surface.

Lift the alpha-SE by the handles as shown.

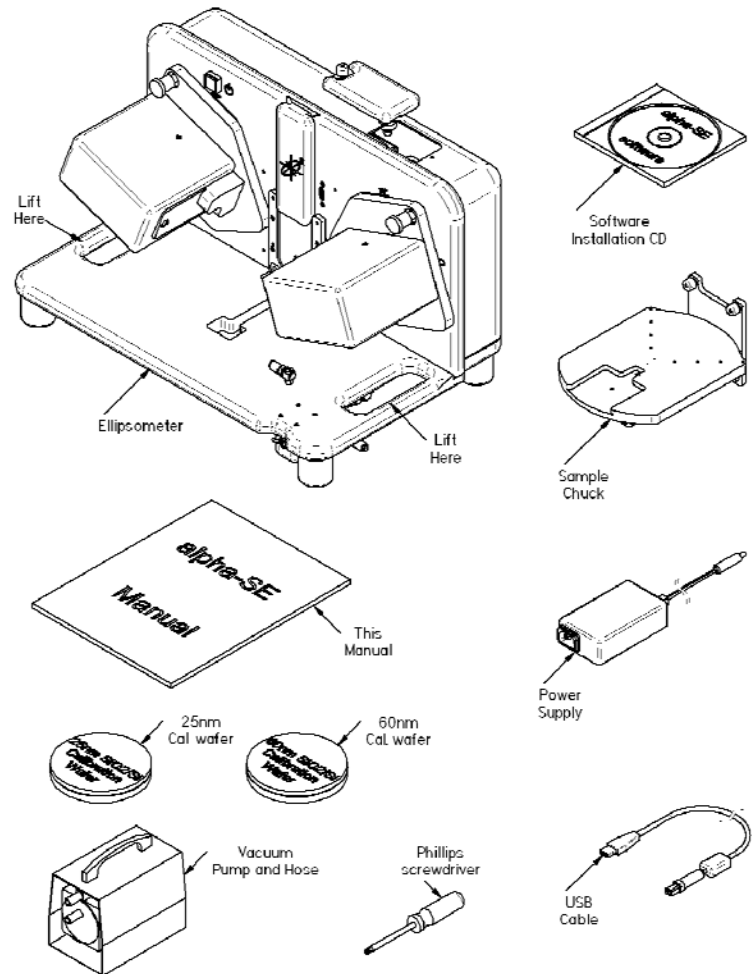


Figure 2-3. alpha-SE shipping container contents.

Attaching the Sample Chuck

You will need a #2 Phillips screwdriver for this step. Following the details shown in Figure 2-4, install the sample chuck by first aligning the pins on the bottom of the sample chuck with the receptacles on the alpha-SE base. Then tighten the upper two captive thumb screws. Next, use the Phillips screwdriver to tighten the lower two captive screws. Don't over tighten the screws! It will make it difficult to remove them in the future; just ensure that the screws are snug. Finally, connect the vacuum line from the sample chuck to the vacuum fitting on the alpha-SE base.

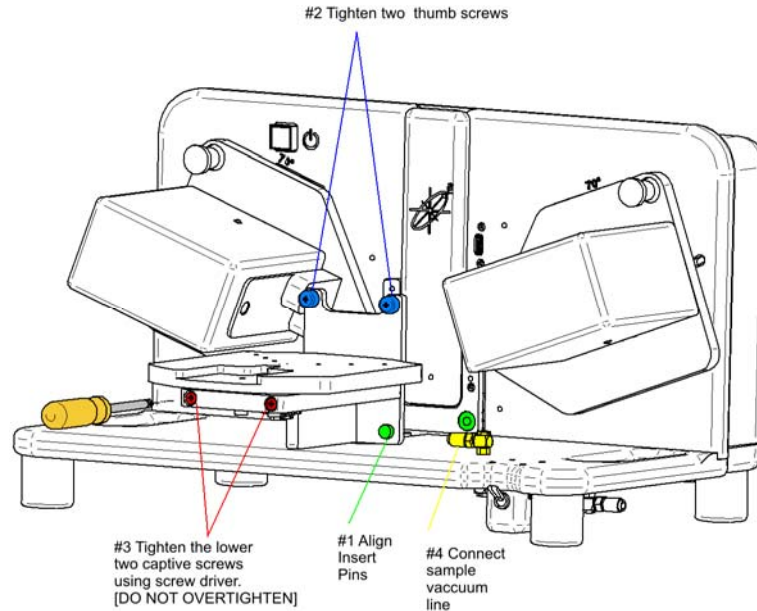


Figure 2-4. Sample chuck installation.

Releasing the Z-stage Shipping Lock

To access the Z-stage shipping lock, first loosen the captive screw on the lamp/shipping lock access door, then open the access door by rotating 180°, as shown in Figure 2-5.

To release the Z-stage shipping lock, stand in front of the ellipsometer and use your left hand to balance the weight of the Z-stage (you will feel it lift up slightly). It will be difficult to release the shipping lock if you apply too much or not enough upward force. Next, use your right hand to move the shipping lock to the operating position (to the right, see Figure 2-6). If the lock is hard to move, you can use a tool to gain more leverage. The shipping lock will move about 1/3" [8mm] to the right.

Checking the Lamp

Check that the QTH lamp is fully seated in the lamp housing. The lamp is located behind the actuator screw (see Figure 2-6) and has two white wires protruding from the back of the lamp. Simply push down on the lamp ensuring that the lamp is fully seated in the lamp housing.

Rotate the lamp/shipping lock access door to the closed position and hand tighten the captive screw.

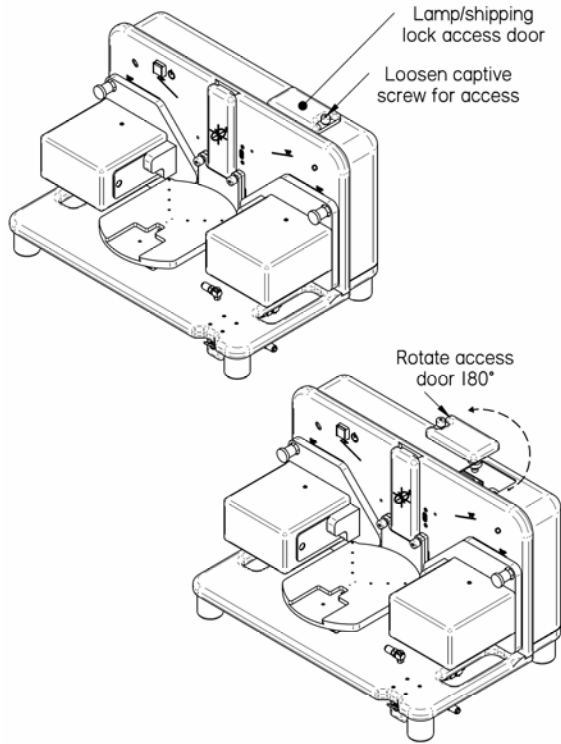


Figure 2-5. Open access door to lamp/shipping lock..

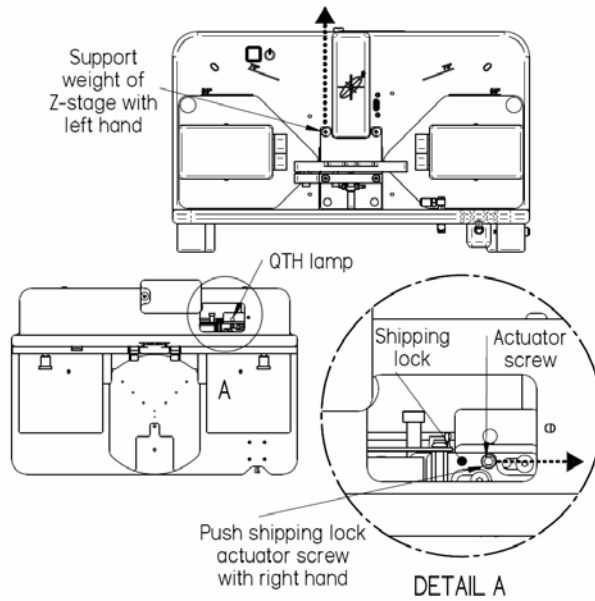


Figure 2-6. Instructions for releasing the shipping lock.

2.4. Installing the Software

Before Installation

Verify that the computer used to operate the alpha-SE system meets all the requirements listed in Table 2-2. Microsoft Windows XP is the preferred operating system.

Table 2-2. Computer requirements for the CompleteEASE software.

COMPUTER SPECIFICATIONS	REQUIREMENTS
Operating System	Microsoft Windows 98, ME, 2000, XP, Vista
Memory (RAM)	256 MB
Hard Disk Space	120 MB
USB Ports	1 required, version 1.1 or higher
Processor	Intel Pentium III, AMD Athlon, or higher 1 GHz clock speed or faster
Display	Color display at least 800x600 pixel resolution

Running the SETUP Program

The configuration files are unique for each alpha-SE system. If you have problems with installation, consult the Troubleshooting Guide in Section 12.2

Run the “CompleteEASE_Setup_3.59.EXE” application from the provided installation CD. This program is located on the CD along with a folder named “CNF” that contains the configuration files to match one specific alpha-SE system. Setup will install the CompleteEASE program files, the Java Virtual Machine (VM) files which are required to run CompleteEASE, and other related files (material optical constants files, optical model files, example files, etc.). The CompleteEASE_Setup program also installs the calibration and configuration files for your specific instrument from the “CNF” directory on the CD.

Follow the onscreen prompts provided by the CompleteEASE_Setup program. The default directory for installation is the C:\CompleteEASE\ directory. To minimize compatibility problems, it is recommended to install the software in this directory. This is shown in Figure 2-7. The installation CD includes configuration files for one specific alpha-SE. If you are installing the CompleteEASE software to run this alpha-SE, make sure to choose “Full Installation” as shown in Figure 2-8. The CompleteEASE software can be installed on any number of computers for data analysis purposes. If you are installing software on a computer that will not operate the alpha-SE system, choose “Data Analysis Only”, as shown in Figure 2-8.

NOTE: The CompleteEASE software is **only** compatible with the encoded Experimental Data files measured using CompleteEASE. Thus, you can install CompleteEASE at multiple computers, but only for use with data collected by CompleteEASE.

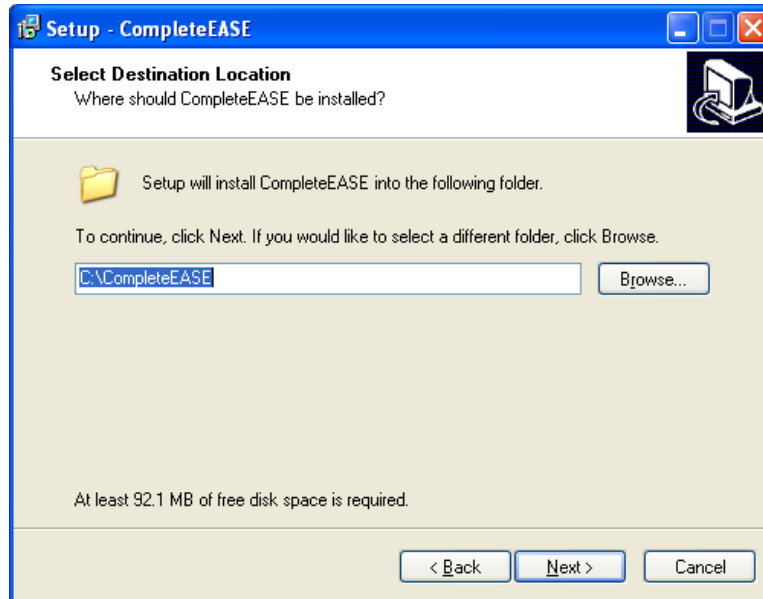


Figure 2-7. Default folder location for CompleteEASE installation.

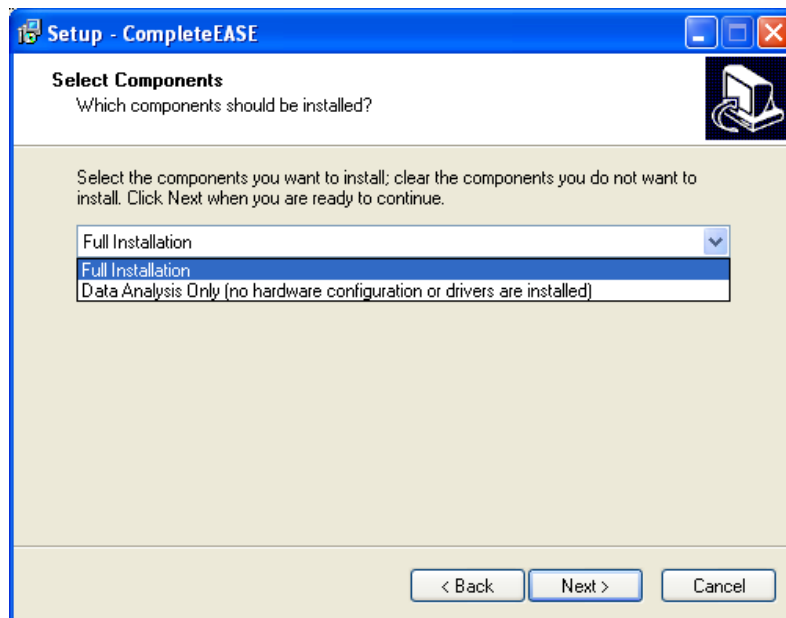


Figure 2-8. CompleteEASE Setup choices. The software can be installed for use with an alpha-SE system or for data analysis only.

The next message you will receive asks which tasks you would like the installation software to perform. The choice ranges from creating icons to associating CompleteEASE file types. These possibilities are shown in Figure 2-9. If you choose, a short-cut icon (Figure 2-10) will be placed on the Windows Desktop to start the CompleteEASE program. However, do NOT start CompleteEASE until

following the system connection instructions. The software installation process should take less than one minute on most computers.

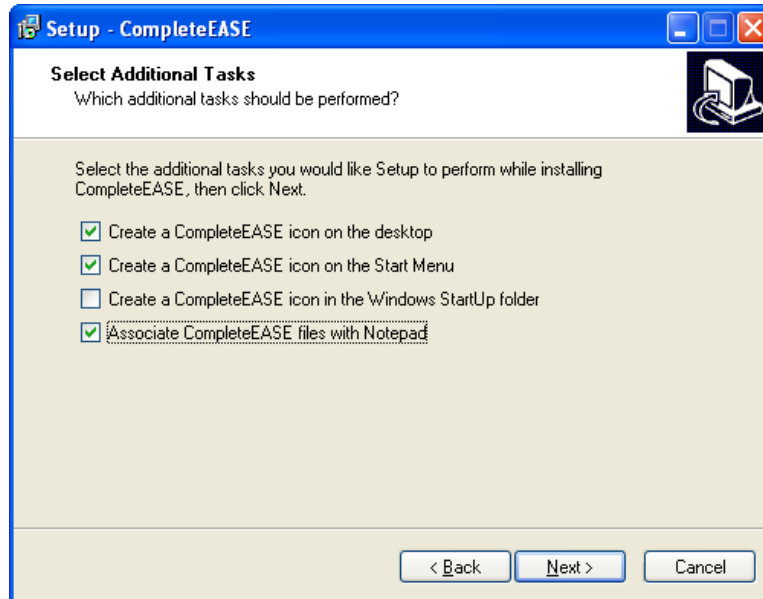


Figure 2-9. Additional Tasks desired during installation of CompleteEASE.

DO NOT start the CompleteEASE program at this time.



Figure 2-10. CompleteEASE icon.

Connecting the alpha-SE

Connect the vacuum hose, power and USB connections to the back of the alpha-SE as shown in Figure 2-11. Also, connect the vacuum hose to the vacuum pump, the power cable to outlet, and the other end of the USB cord to the computer. The vacuum pump will need to be turned on before mounting samples.

Turn on the power to the alpha-SE unit by pressing the green power switch. If the switch does not “light up”, check the power connections.

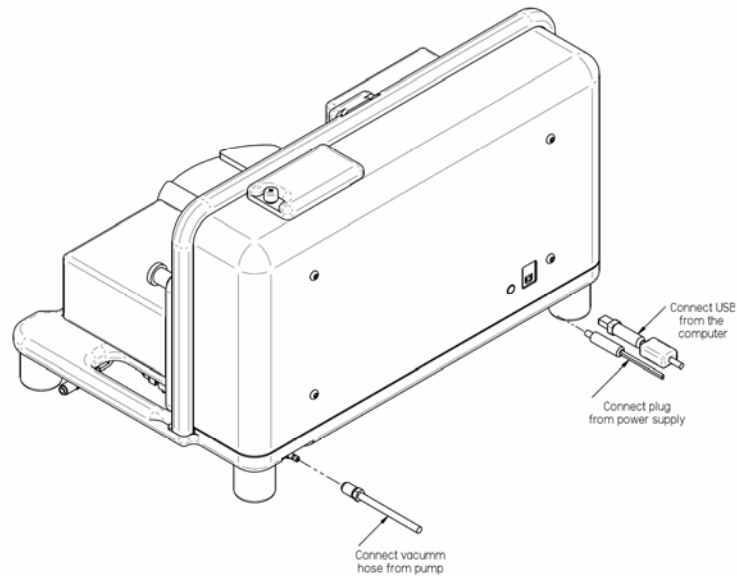


Figure 2-11. Connect vacuum, power and USB connections.

Installing the alpha-SE USB Drivers

When the alpha-SE unit is connected to the computer with the USB cable, Windows will automatically detect that new hardware has been attached to the computer. On some Microsoft operating systems (such as Windows XP), a “new hardware” message (Figure 2-12) will be briefly displayed near the taskbar.

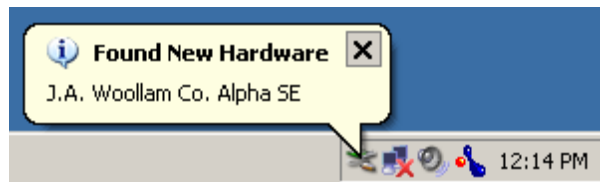


Figure 2-12. Message displayed in Windows XP when alpha-SE is initially connected to computer.

In Windows XP (Service Pack 2), the dialog box in Figure 2-13 will be displayed next. Choose “No, not this time” and press “Next>”. Then, from the dialog box of Figure 2-14, select the “Install the software automatically” option, and click the “Next>” button. Other Windows versions may display similar dialog boxes; select “(Recommended)” option and click “Next”.

Windows will then install the alpha-SE drivers. Figure 2-15 shows the dialog boxes displayed under Windows XP during the installation process. Click the “Finish” button when prompted.



Figure 2-13. Found New Hardware Dialog box displayed in Windows XP.



Figure 2-14. "New Hardware Wizard" dialog box displayed in Windows XP.

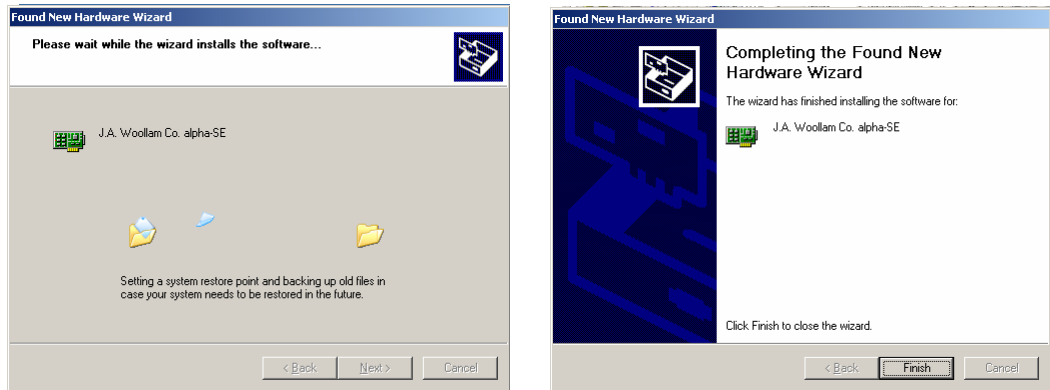


Figure 2-15. Dialog boxes displayed by Windows XP during installation of alpha-SE drivers.

Verifying the alpha-SE Driver Installation

To verify the proper installation of the alpha-SE drivers, open the Windows “Device Manager”.

- In Windows 2000 and XP, right-click on the “My Computer” icon, select “Properties”, click on the *Hardware* tab, and then click the “Device Manager” button.
- In Windows 98 and ME, right-click on the “My Computer” icon, select “Properties”, click on the *Device Manager* tab.

If the alpha-SE drivers have been successfully installed, a “J.A. Woollam Co. Devices” heading will appear, and a “J.A. Woollam Co. alpha-SE” device will be present in the list, as in Figure 2-16.

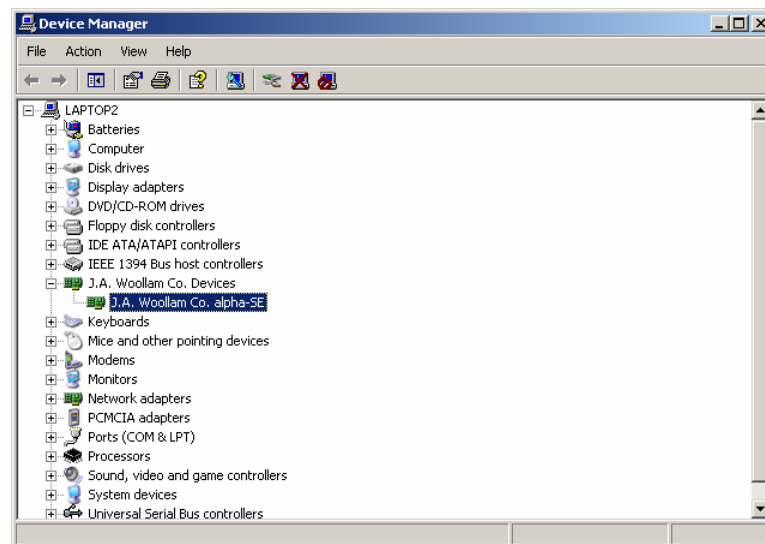


Figure 2-16. Windows Device Manager after successful installation of drivers.

If the alpha-SE drivers have not been successfully installed, the “Device Manager” screen may show a “J.A. Woollam Co. Alpha SE” entry under the “Unknown Devices” heading, as shown in Figure 2-17. The most common cause of this problem is plugging the alpha-SE into the USB port before running the CompleteEASE “SETUP” program. To remedy this problem:

1. “Right-click” on the “J.A. Woollam Co. Alpha SE” entry and select the “Uninstall” or “Remove” option.
2. Unplug the USB cable from the alpha-SE system. Run the CompleteEASE “SETUP” program (earlier in this section).
3. Plug the USB cable into the alpha-SE system, and repeat the steps earlier in this section of the manual.

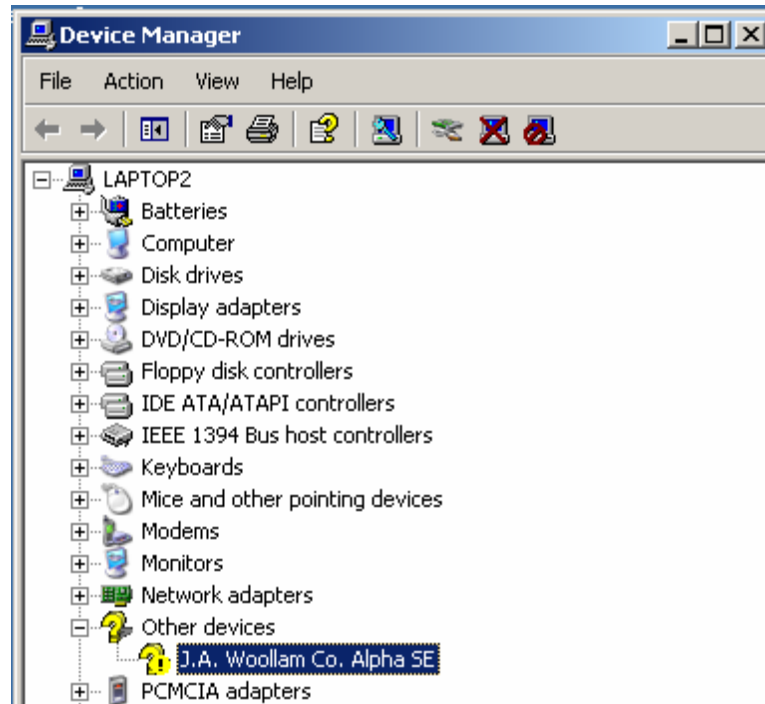


Figure 2-17. Windows Device Manager after unsuccessful installation of drivers.

2.5. Initial System Operation

alpha-SE System Components

The various components of the alpha-SE system are named as shown in Figure 2-18. These names will be used throughout this manual.

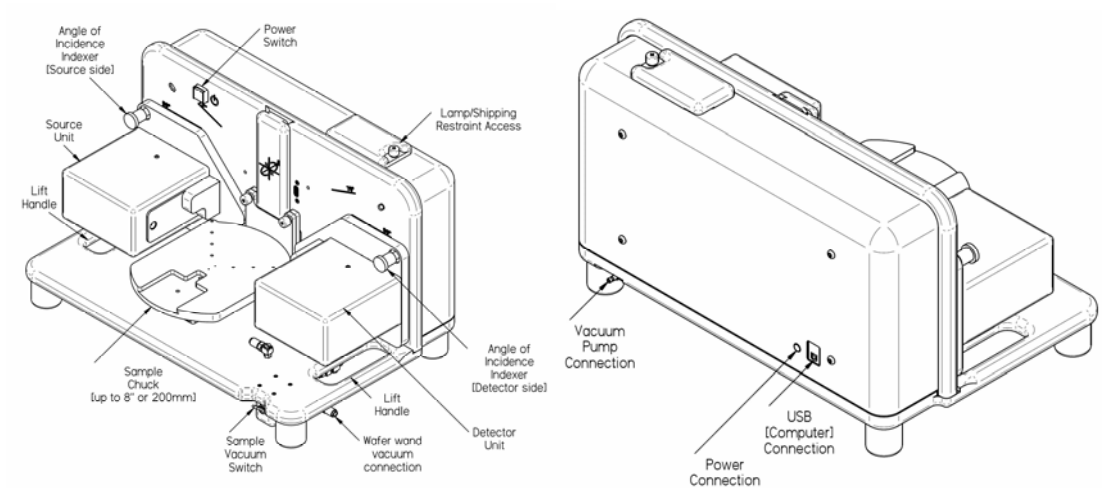


Figure 2-18. alpha-SE system components.

Running the CompleteEASE Software

Start the CompleteEASE software by double-clicking the “CompleteEASE” icon on the Windows Desktop. A CompleteEASE splash screen will first display, and then the CompleteEASE main screen will appear, as shown in Figure 2-19. The software will automatically begin initializing the alpha-SE hardware and the status of initialization process will be displayed in the System Status section of the screen. If hardware initialization is successful, the System Status message will change to “Waiting to Acquire Data” as shown in Figure 2-19.

If an error occurs during hardware initialization, a message box may appear describing the problem. If the problem is not easily fixed (such as “Please turn the alpha-SE power ON” error message), contact your J.A. Woollam Co., Inc. representative before continuing (Section 12.4).

NOTE: Additional information about a hardware error can be found by clicking the “Hardware Log” button from the *Hardware* tab.

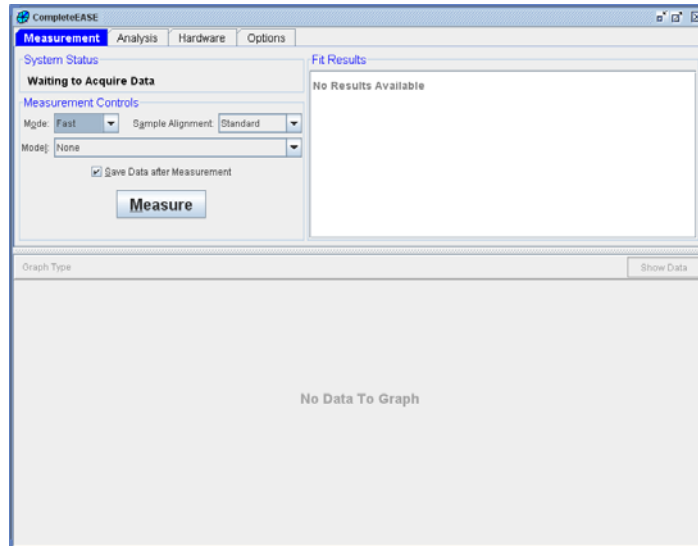


Figure 2-19. CompleteEASE after successful hardware initialization.

Checking Beam Alignment at 90°

Verify that the beam is centered on the detector unit aperture when the alpha-SE system is in the “Straight-Through” or 90° configuration, as shown in Figure 2-20. If the system is not set to 90°, pull out the “AOI Indexer” knobs on the source and detector units and adjust the system to the 90° position (Figure 2-23). If the beam is not centered on the receiver aperture, consult the Troubleshooting Guide (Section 12.2).

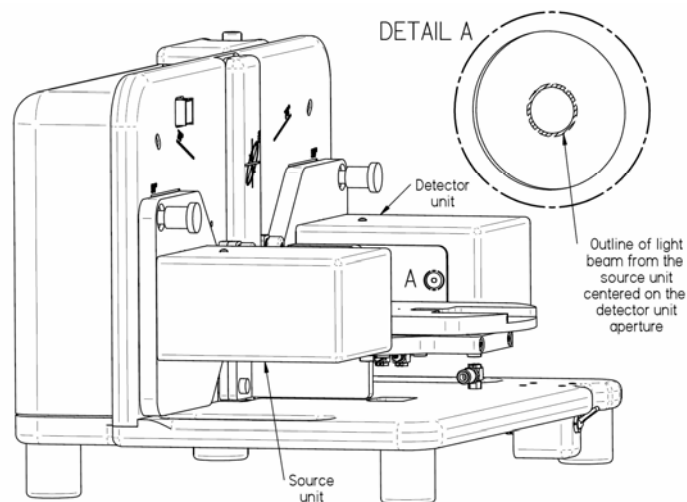


Figure 2-20. Verifying that the beam is centered on the detector aperture with the alpha-SE system in the “Straight-Through” configuration.

Checking Signal Intensity

With the alpha-SE base in the straight-through (90°) position (as in Figure 2-20), click **Hardware**>‘Max. Sig. Display’. The CompleteEASE screen should appear similar to that shown in Figure 2-21. Acceptable values for the average signal

intensity (the “Ave=” value) range from 500 – 2000; maximum signal intensity values range can range from 1200 – 3200.

Low Intensity

If the observed “Ave” and “Max” values are lower than these acceptance ranges, verify that the lamp is properly seated. If the intensities are still low, try installing a new lamp (section 12.1). If this fails to bring the intensities within the acceptable range, please contact your J.A. Woollam Co., Inc. representative (Section 12.4).

High Intensity

If the observed “Max” value exceeds the acceptance range, open the lamp access door and slowly pull the lamp out until the “Max” value is within the acceptable range.

NOTE: After Checking the Signal Intensity, press the ‘Cancel Signal Display’ button in the top-center of the screen (or press ESC key).

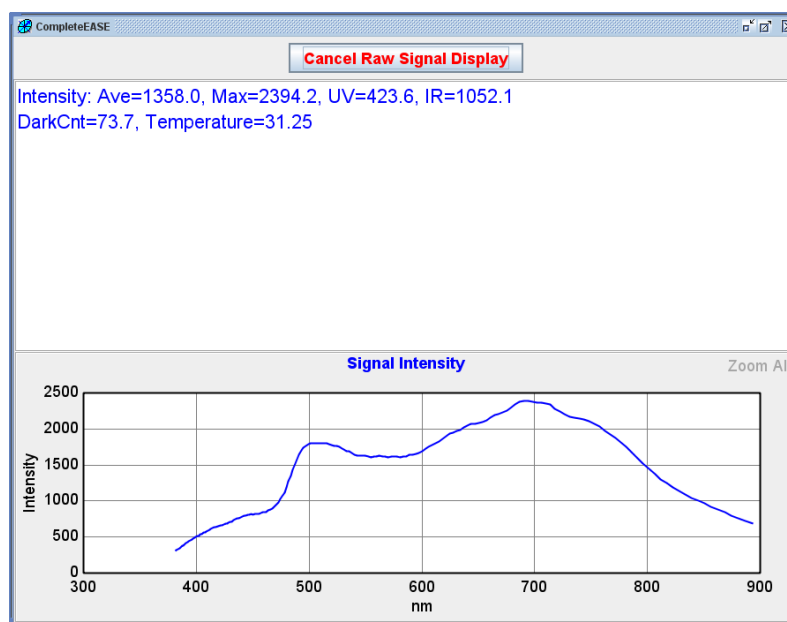


Figure 2-21. Typical “Max. Sig. Display” screen with alpha-SE at 90°.

Acquiring Straight-Through SE Data

Ellipsometer accuracy is verified on a known sample. However, due to the high sensitivity of SE measurements to surface conditions and film changes, the most stable reference is air. To check the ellipsometric accuracy of the alpha-SE system, adjust the AOI to the 90° (“Straight Through”) configuration. On the CompleteEASE *Measurement* tab, choose the following settings (also shown in Figure 2-22):

MODE	SAMPLE ALIGNMENT	MODEL
Long	None	None

Click ‘Measure’. The “Long” measurement will take about 30 seconds, and the measured spectroscopic ellipsometric (SE) data will be graphed in the bottom half of the CompleteEASE screen (Figure 2-22).

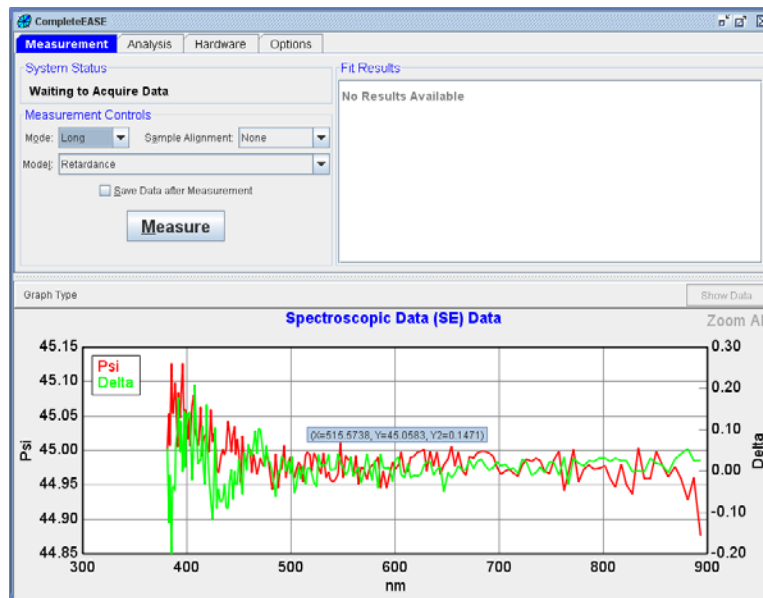


Figure 2-22. Typical Straight-Through (90°) SE data.

The alpha-SE system should be warm before measurements. For best results, leave system on for 30 minutes prior to start.

Ideally, a Straight-Through measurement of “air” should yield Psi values of 45° and Delta values of 0°, independent of wavelength. The target acceptance range for an alpha-SE system is within $\pm 0.1^\circ$ of the ideal Psi values ($44.9^\circ < \text{Psi} < 45.1^\circ$) and within $\pm 0.2^\circ$ of the ideal Delta values ($-0.2^\circ < \text{Delta} < 0.2^\circ$). Typically this acceptance range is achieved over most of the spectrum, except at the longest and shortest wavelengths where noise may cause the data to slightly exceed the accuracy target. If measurements are outside these limits, please contact the J.A. Woollam Company (Section 12.4).

Changing the Angle of Incidence (AOI)

Figure 2-23 and Figure 2-24 show how to change the Angle of Incidence (AOI). Two angles are possible: 90° (also called the “Straight-Through” configuration) and 70° (also called the “Off-Sample” configuration).

NOTE: The top edge of source and detector units should line up with the engraved 70° or 90° reference lines before releasing AOI indexer knobs.

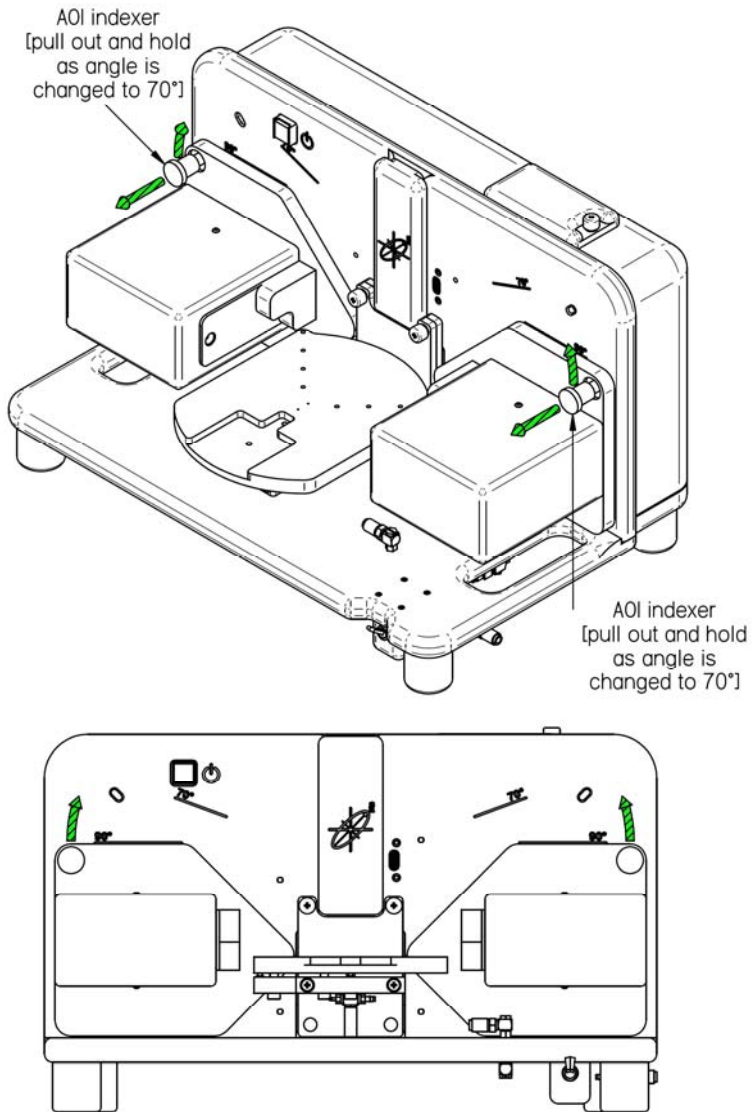


Figure 2-23. Changing the Angle of Incidence (AOI) of the alpha-SE system.

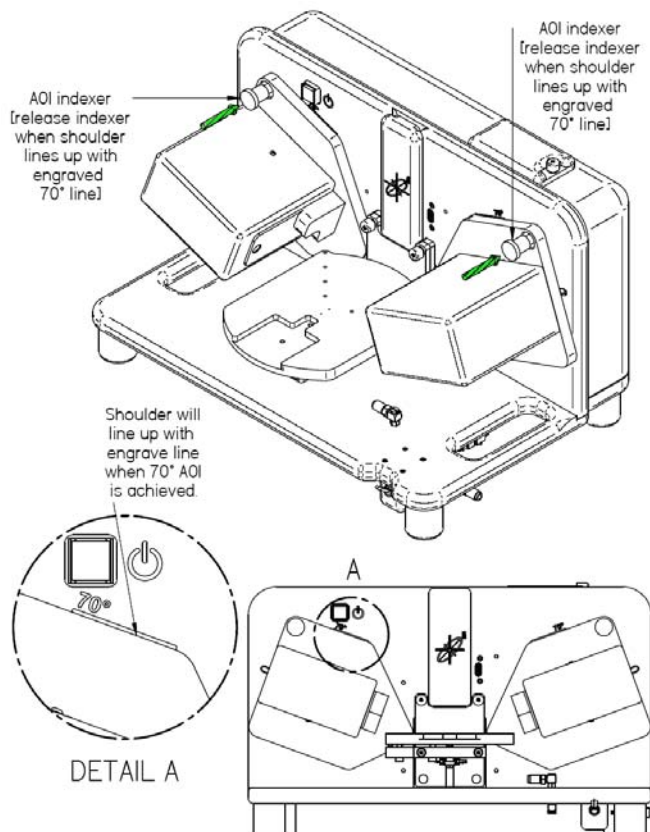


Figure 2-24. alpha-SE system set to the 70° (“Off-Sample”) configuration.

Measuring the Reference Wafer

Adjust the alpha-SE system to the 70° position, and mount the 25nm (250Å) calibration wafer as shown in Figure 2-25. On the CompleteEASE *Measurement* tab, choose the following settings:

MODE	SAMPLE ALIGNMENT	MODEL
Standard	Standard	25nm Oxide on Si (in Calibration Wafers folder)

Click ‘Measure’ to begin the measurement. The alpha-SE system will first adjust the sample height (“Z-height”) to center the beam on the detector unit aperture, and then spectroscopic ellipsometric (SE) data will be acquired. After acquiring data, the selected model will be used to analyze the data, and the results will be presented in both graphical and text format, as shown in Figure 2-26.

The entire process (alignment, measurement, and analysis) should take less than twenty seconds for a standard measurement.

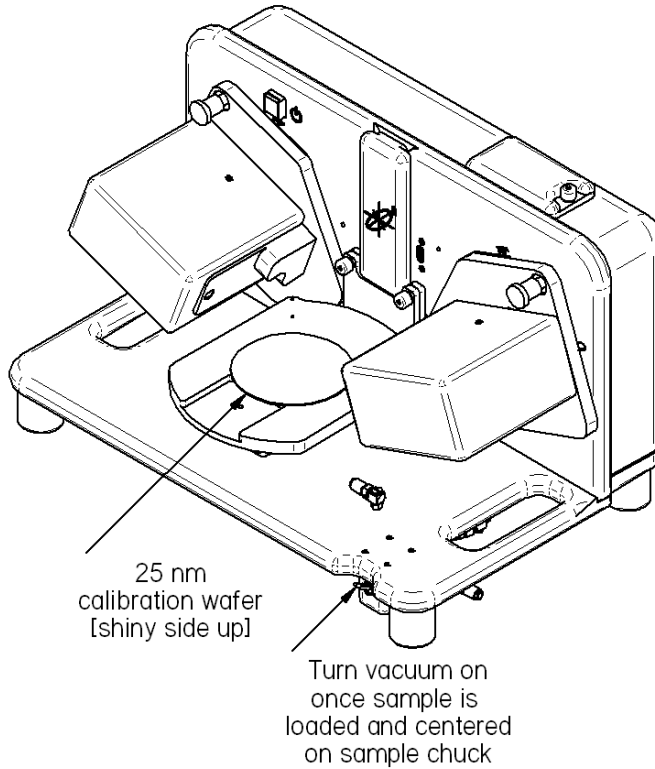


Figure 2-25. Calibration wafer mounted on the alpha-SE system at 70°.

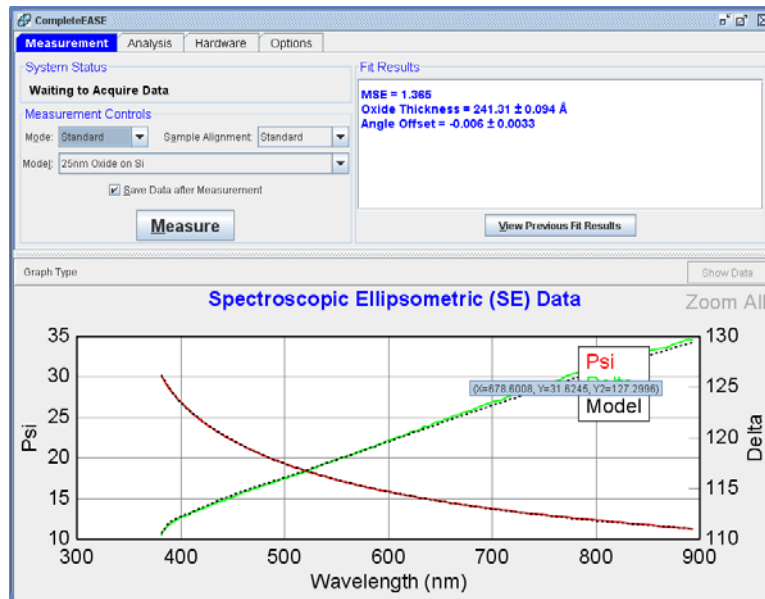


Figure 2-26. CompleteEASE screen after measuring 25nm reference wafer.

The SE Data graph on the bottom half of the CompleteEASE screen displays the experimentally measured ellipsometric parameters “Psi” and “Delta” vs. wavelength as solid colored curves (red for the “Psi” data, and green for the “Delta” data). The black dashed curves are generated by the model analysis of the data. If the model “fits” the data, the black dashed model curves lie essentially on top of the experimental colored curves, as shown in Figure 2-26.

The “MSE” value, shown in the upper right corner of the CompleteEASE screen, quantifies how well the model data “fits” or “matches” the experimental data. (“MSE” stands for Mean Squared Error.) The lower the MSE value, the better the data fit. The acceptable MSE range for alpha-SE measurements on the 25nm calibration wafer is 0.5 – 3.0. If the reported MSE is within this acceptance range, the alpha-SE system is acquiring accurate off-sample SE data.

If the MSE is outside these limits, try remounting the sample, ensuring that it sits firmly on the sample chuck and that the sample surface is clean, and perform another measurement. As an additional check on the alpha-SE system alignment, verify that the beam is centered on the detector unit aperture after the measurement. If the MSE is still outside the acceptance limits, please contact your J.A. Woollam Co., Inc. representative (Section 12.4)

2.6. Powering Down

The alpha-SE system can be left on continuously if desired. However, the Quartz-Tungsten-Halogen (QTH) lamp has a rated lifetime of 1500 hours. To maximize lamp life, turn off the system when not in use for extended periods of time. To power down the system:

- Close software
- Press power button off.

NOTE: The accuracy and precision are lower for a “cold” system. Thus, it is suggested to turn on system for ½ hour before taking measurements.