AtOMS Software Suite

User Manual

Release 1.1.0

Contents

Hardware Setup

Back Panel

1. **Signal Output:** Light is emitted through these channels from the HCL. An SMA fiber optic should be attached leading to the emission optics on the system being monitored.
2. **Signal Input:** Return light coming through the stem being monitored comes into this SMA connector. An SMA fiber optic should be attached leading to the receiving optics on the system being monitored.
3. **HDMI Video Output:** Standard size HDMI video output for attaching to a display.
4. **Power:** AC Power Input 100-120V/5A

Front Panel

1. **USB 1+2:** USB A ports for attaching a keyboard and mouse or a USB drive.
2. **UV Light Indicator:** When the HCL is in use this light will be illuminated indicating the presence of UV light. Ensure proper eye protection if the HCL compartment needs to be opened while the indicator light is on.
3. **Power Button:** When the system is on the button will be illuminated in blue. To turn the system on press the button down to begin startup. To turn system off either shut down from Windows or press and hold Power Button for several seconds until system initiates safe shutdown.
4. **HCL Compartment:** This compartment is where the HCL and associated optics are located. While system is in use this compartment should always be shut and locked to ensure that UV light is not being released into the room. *The only times that this compartment should be open while the system is in use is for adjusting the power reference and initial optical setup of a new HCL. If either of these actions is being performed ensure all users are wearing proper eye protection.*

HCL Compartment

1. **HCL Power Slot:** The system is designed for a standard 2-prong HCL. The HCL and connector are keyed so that the HCL is only capable of going in one direction. ***Ensure the AtOMS system is powered down when replacing Hollow Cathode Lamps.***
2. **HCL Clip:** Clip to stabilize and hold the HCL in place. Clip is keyed in one direction and held in place with 2x 6-32 button head screws.
3. **Slide Rail Optics:** Optics to focus the HCL onto the collector. Once maximum intensity has been reached tighten optics in place using the hand screws.

4. **XY Stage Adjustment:** Adjust XY stage in order to maximize light into the system when replacing HCL.
5. **Reference Power Adjustment:** When setting up system, ensure that the power of the reference signal is similar to the power of the signal in the chamber using the mechanical wheel to adjust the reference signal. It is recommended to run the system with the initial reference and chamber signals within 5% of each other to improve the signal to noise of the resulting data.
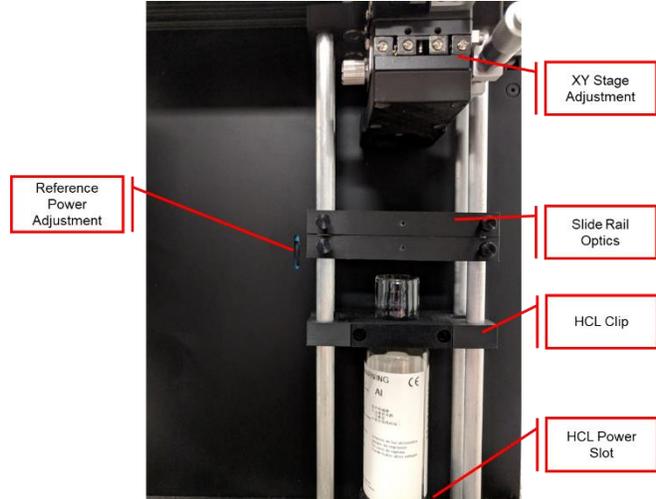
External Hardware

1. **Fiber Patch Cords:** For the standard system with 1 output and 1 input channel there will be 2 fiber patch cords to connect. The first patch cord will connect between the **Signal Output** on the AtOMS box and the **Emitter Optics** on the chamber. The second patch cord will connect between **Signal Input** on the AtOMS box and the **Collector Optics** on the chamber. To connect the patch cords, insert the SMA ferrule on each side into the SMA barrel connector and turn the threads clockwise until tight.
2. **Emitter Optics:** The optics used generally change based on a use-case basis. In most instances there will be an XY stage on the side of the emitter optics used to position the optics for maximum signal throughput. The optics themselves are held in place via a 4-40 set screw that should be loosened in order to do any maintenance on the optics.
3. **Collector Optics:** The collector optics will generally be attached to the chamber via a fixed position mount with a 4-40 set screw holding the optics to the mount. In order to remove the optics, loosen set screw before pulling collector optics out of the mount. In some cases, there will be an additional XY stage for the collector optics, in this case both the Emitter and Collector Optics XY stages will need to be positioned simultaneously in order to maximize signal throughput.

Getting Started

1. Plug system into 110V AC power source using provided power cord.
2. In HCL Compartment, plug desired HCL into HCL Power Slot and tighten in place using the HCL Clip.
3. Turn on system using Power Button on front panel
4. Confirm that the Fiber Patch Cords are connected to the Emitter and Collector Optics on the chamber
5. Once system has completed boot-up open AtOMS Software Suite
6. Set based software settings:
    a. Go to System->Hollow Cathode Settings and set the current provided to the HCL based on the specifications provided by the HCL manufacturer. ***It is extremely***

> *important to stay within the current bounds that the manufacturer specifies as going outside of these bounds can damage the HCL.*

      b. In software go to Detector->Integration Settings and set the value to 30ms. *This value is not fixed and can change based on user experience.*

      c. In software go to Detector->Scans to Average and set the value to 5

      d. In software go to Detector->Set Shutter Ratio and verify the value is set to 1

7. Turn on HCL and begin taking data using Start Acquisition
8. Optical Alignment
    a. First, using the HCL Reference in the spectrum tab to view the data, open the HCL compartment (please use proper protective eyewear while doing so) and adjust the XY stage and rail optics to maximize the intensity of the light being measured.
    b. Next, use the AAS+AES in the spectrum tab to adjust the XY stage on the chamber to maximize the signal through the chamber.
    c. In the HCL compartment use the Reference Power Adjustment wheel to make primary peak for the HCL Reference and AAS+AES approximately equal. You want these values to be within 5-10% of each other for best signal to noise.
9. In Detector->Integration Settings change the integration time so that the AAS+AES and HCL Reference peak values are approximately 45,000 with neither value being greater than 50,000.
10. Once the integration time is determined adjust the Scans to Average to the desired level of signal to noise vs data collection time. The data collection time for a full scan in seconds is approximately equal to 4 x (Scans to Average) x (Integration Time / 1000)
11. Verify there is no deposition going on in the monitored chamber and take a reference.

Main Panel

Take Reference
To properly calculate absorption values, the AtOMS requires a reference reading. This reference should be taken when there is no deposition occurring. The reference should also be taken prior each run. Taking a reference will also automatically start acquiring data.

Start Data Acquisition
This button will start the data acquisition for the system.

Stop Data Acquisition
This button will stop the data acquisition for the system.

Start Recording
This button will start recording data that is being acquired in a new file. Recording can only occur if a reference has been taken.

Stop Recording
This button will start the data acquisition for the system.

Lamp Control Display
This panel controls the hollow cathode lamp. The panel will auto-populate with the correct number of lamps that the system has installed. The circle indicates the current lamp status. The light bulb toggles the lamp.

Lamp Configuration Panel

Lamp Toggled On
Indicates that the user intends for the lamp to be on.

Lamp Toggled Off
Indicates that the user intends for the lamp to be off.

System Status-Lamp On
The AtOMS system is providing power to the Hollow Cathode Lamp.
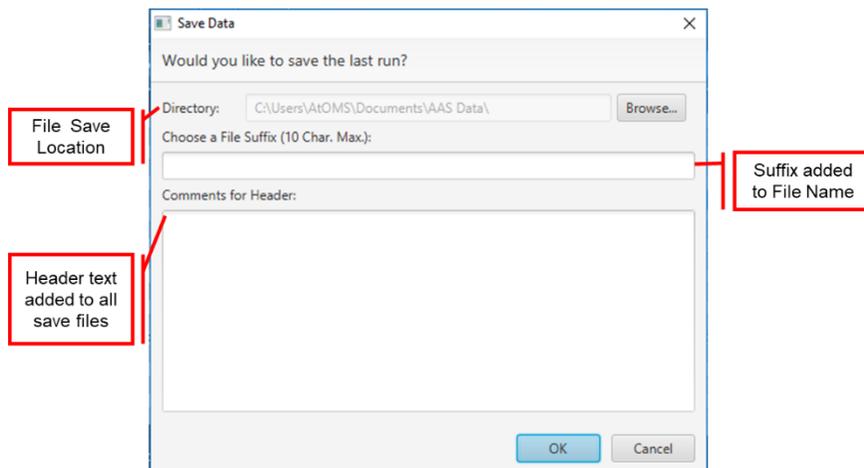
System Status-Lamp Off
The AtOMS system is not providing power to the Hollow Cathode Lamp.

File Saving Structure
The AtOMS uses a Default file locations of:

C:/Users/AtOMS/Documents/AAS Data

After the "Stop Recording" button |🔴| is pressed, a popup will open.

The **Directory** can be changed with the first "Directory" field. The **File Suffix** is text that will be appended to all files that are created. The **Header** field is appended inside every file that is saved.

The file Naming scheme is as follows:

AAS Data/YYYY_MM_DD/HH_MM_SS Suffix/

Within the folder there will be 4 .csv files and another folder that contains all processed data. The 4 .csv files are the raw data taken by the system. The processed data folder contains a file for each tracked element.

Spectrum Tab

The Spectrometer Tab Displays the raw spectral data that the AtOMS system is measuring. There are 4 types of data that can be displayed on this panel.

AAS + AES

Displays the total raw counts that have been measured. The signal will inherently contain both atomic absorption and atomic emission signal for each spectral line.

AES

Displays the atomic emission. This is taken by blocking the Hollow Cathode Lamp light and measuring the native emission from the chamber.

HCL Reference

Displays the "power measurement" of the Hollow Cathode Tube. This is taken by passing the light from the Hollow Cathode Tube directly to the spectrometer, bypassing the deposition chamber.
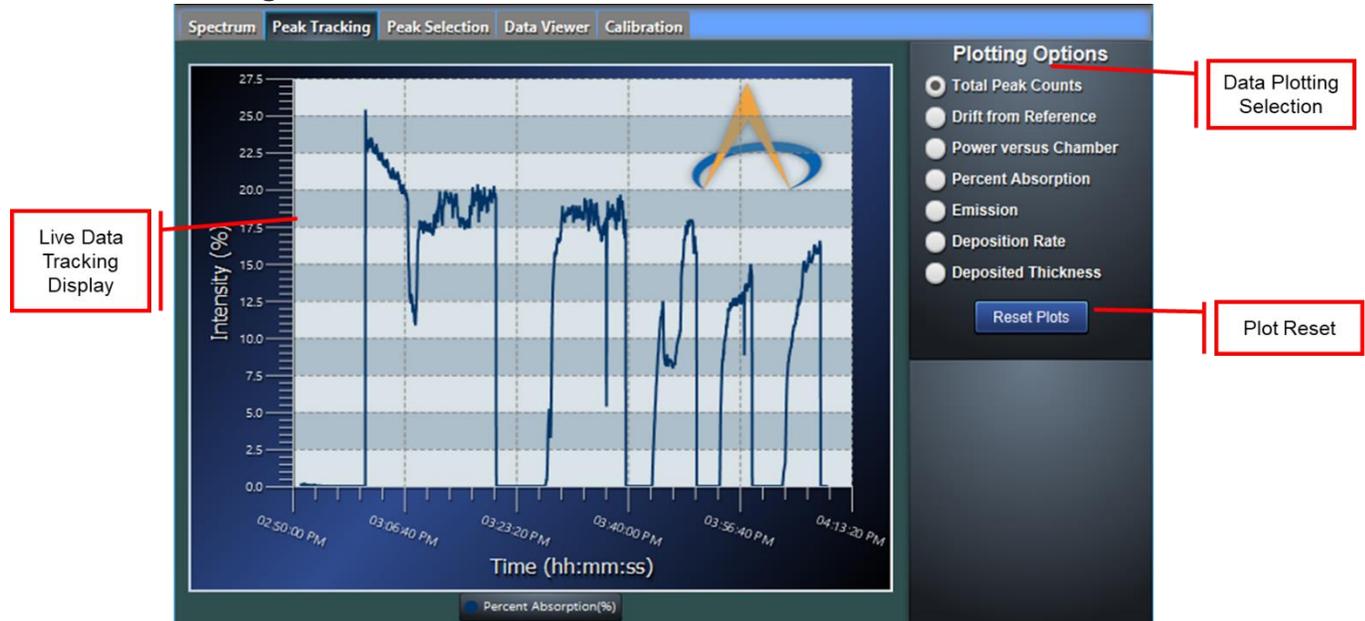
Baseline

Displays the baseline of the spectrometer. It is acquired by measuring the signal that is being received with the Hollow Cathode Lamp turned off and by passing the chamber.

Reference Measurement

Displays the total power of the Hollow Cathode Lamp that was taken during the reference phase of the acquisition. ||

Peak Tracking Tab

The peak tracking tab is the main tab for monitoring a process with the AtOMS system. The software provides a variety of ways to view the data. The panel includes data tracking options which can be selected with the radio button on the right. The plotted data can be reset by using the "Plot Reset" button on the right side of the panel.

Total Peak Counts
Tracks the total power of the elemental peak outside of the chamber.

Drift from Reference
Tracks the difference between the total peak counts and the original reference peak.

Power versus Chamber
Tracks the difference between the elemental peak outside the chamber and inside the chamber.

Percent Absorption
Tracks the total percent absorption through the chamber. This is the primary data that is used to track the deposition process.

Emission
Tracks the total atomic emission occurring within the chamber during deposition.

Deposition Rate
Tracks the calculated deposition rate based on the calibration files provided for each element.
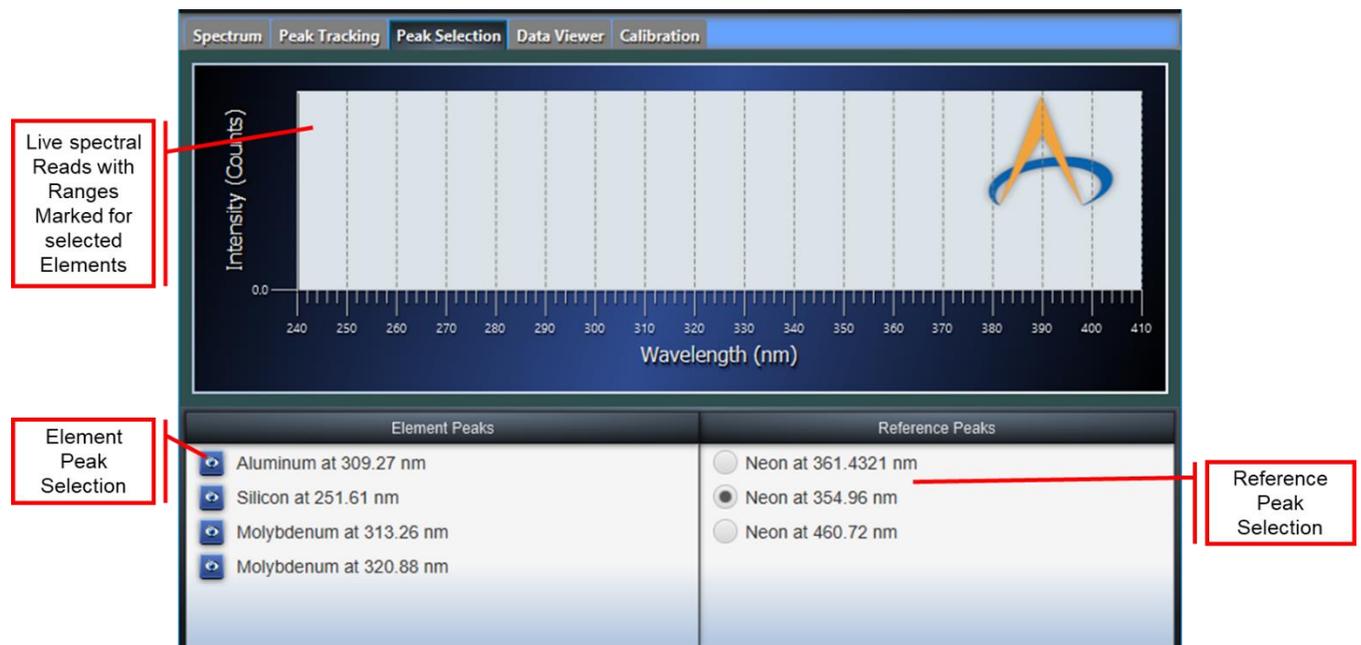
Deposition Thickness

Tracks the total cumulative thickness calculated from the beginning of the deposition.

Peak Selection Tab

The Peak Selection Tab allows the user to select which elements to monitor as well as which reference peak to use. To change which elements are being monitored, toggle the "eyeball" next to each elemental line.

This panel will also display the live readings with rage markers for each of the selected elemental peaks. The range indicated on the plot represents the region over which the peak is integrated.

Data Viewer Tab
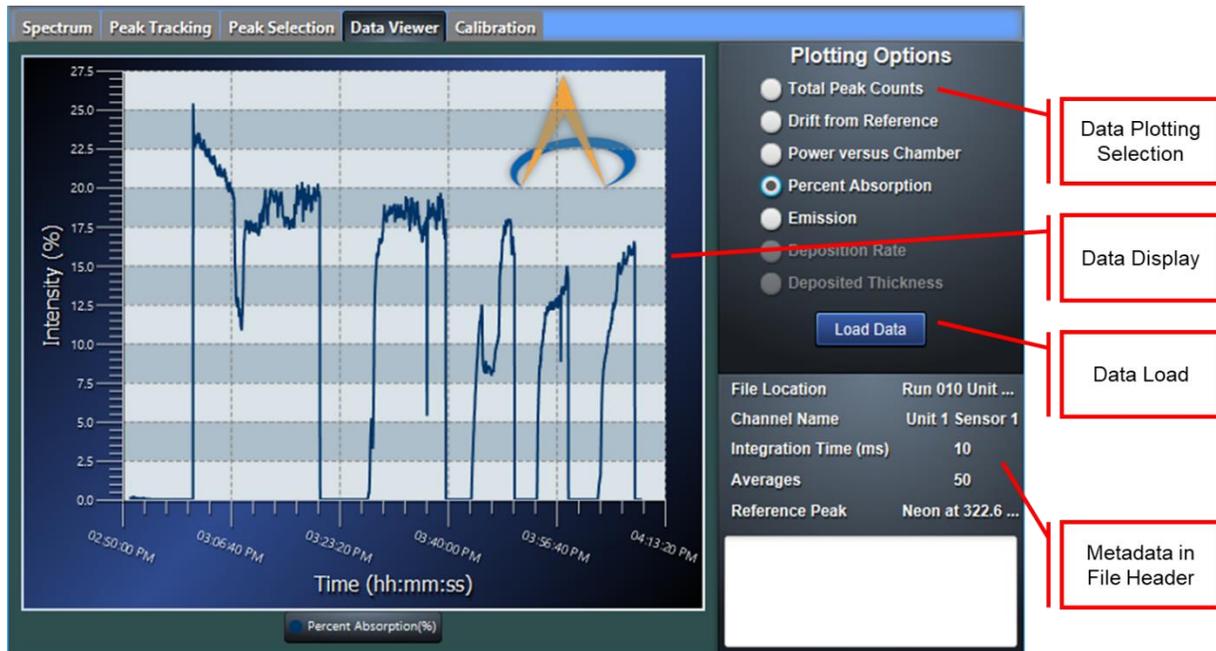
The Data Viewer Tab allows users to review old runs. The user can select between each of the plots by using the "Plotting Options" radio buttons. The metadata about the run including filename, sensor information, integration time, number of averages and the reference peak used for the data as well as any comments saved by the user will be displayed in the "Metadata" section. To load data, press the "Load Data" button and select the desired file.

Warning: Only the processed files saved by the AtOMS system will display properly. Raw data files will not open successfully

Calibration Tab
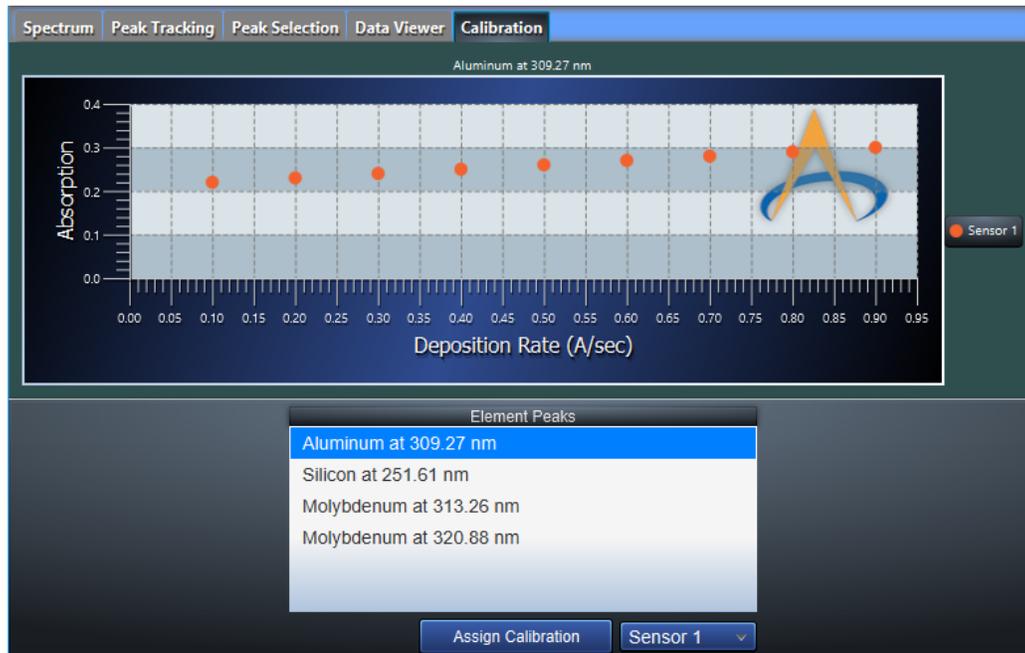
The Calibration tab is used to provide calibration curves that can be used to convert atomic absorption to deposition rate and thickness. To assign a calibration file to a specific elemental peak:

1. Selected the elemental peak that the file will be assigned to from the "Element Peaks" list.
2. Select the sensor that the calibration file if for from the dropdown box
3. Press the "Assign Calibration" button
4. Select the calibration file

When an element is selected, the currently assigned calibration data for each sensor is displayed in the plot. If no calibration data is assigned, the plot will be blank.

To change a calibration file, carry out the assignment procedure and select the new file for the selected element.

System Menu

Setup Spectrometer Display

This menu allows changes to the Spectrometer tab plot.

Sensors to Display

Selects all sensors to be displayed on the Spectrum tab. Sometimes displaying all sensors at once can make viewing difficult. This option allows users to display only the spectra that are currently being monitor

Edit Peak Description

The Edit Peak Description menu allows users to create new peak definitions for various elements.

List of Currently Defined Peaks

A list of all currently defined peaks that will be selectable in the Peak Selection tab. Information about the element, wavelength range, central wavelength and whether the peak is considered a "references peak" can all be determined by expanding the tree list (down arrow).

Peak Definition Creator

To define a new peak to be used in the Peak Selection tab, fill in the values for the peak under this header. Every peak definition requires:

Element: The element that is being detected by the system. Only elements supported by AtOMS will be displayed in this list. If the desired element is not in the list, please contact customer support.

Central Wavelength: The elemental peak that will be monitored. Many elements have multiple elemental peaks that can be used to monitor. Most commercial HCL manufacturers will include the supported elemental peaks with each lamp.

Wavelength Range: Due to the precise nature of the atomic absorption process, many detectors are not perfectly calibrated for across the entire detector range. The "Minimum Wavelength(nm) and "Maximum Wavelength" values are used to define the region in which the peak will be integrated. These are user defined settings and can vary depending on element, detector and intensity.

Many elements have multiple analytical lines. Most HCL manufactures will include the most useful analytical lines on the HCL container. To the right is an example of an HCL label that comes with a Silicon HCL. The two recommended analytical lines are marked with red boxes. There may be other elemental lines not listed, only the most sensitive lines are included with the lamp container.

Optimization the minimum and maximum wavelength values is critical to system performance and should be tuned to provide maximum sensitivity and better signal to noise.

Hollow Cathode Settings
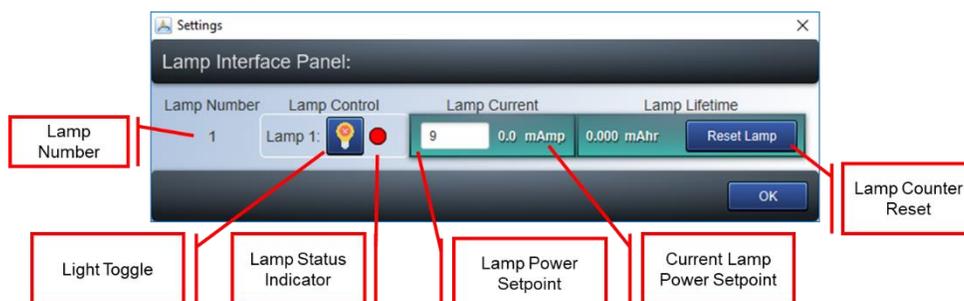
Lamp Toggled On
Indicates that the user intends for the lamp to be on.

Lamp Toggled Off
Indicates that the user intends for the lamp to be off.

System Status-Lamp On
The AtOMS system is providing power to the Hollow Cathode Lamp.

System Status-Lamp Off
The AtOMS system is not providing power to the Hollow Cathode Lamp.

Lamp Current

Provides users with the ability to set the HCL lamp current. Each HCL has different power settings.

To the right there is an example of a Silicon hollow cathode lamp package. Most lamps come with two power specifications. The first is the **Operating Current**. This is the current that is recommended by the manufacture for lamp operation. The second specification is the **Maximum Current**. This is the maximum current that the lamp can be set at without causing damage to the HCL. Both of these values are element and vender specific, so it is critical to ensure that settings are entered correctly before operating the unit.
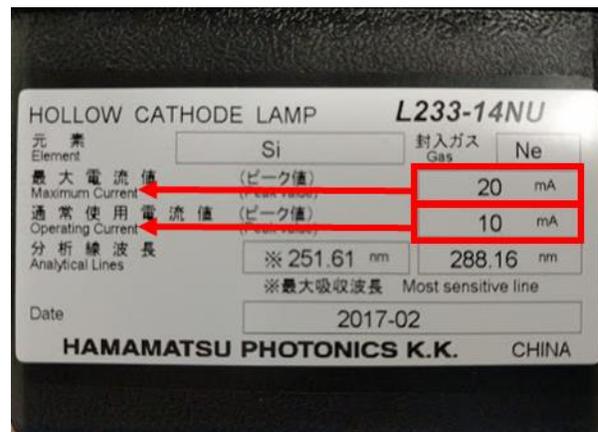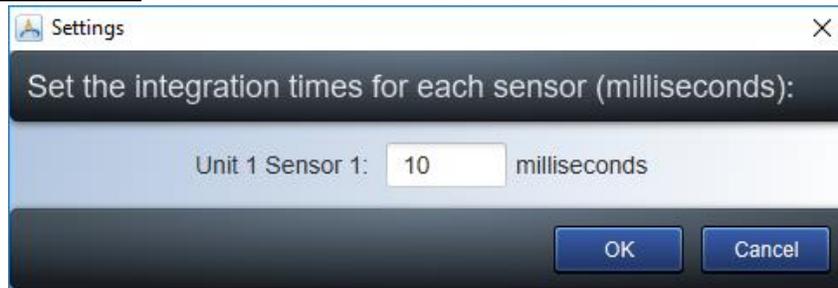

Warning: Incorrect power settings for a lamp can lead to decreased lamp lifetime or catastrophic lamp failure. Use caution when setting up the lamp.

Detector Menu

Set Integration Time

The **Integration Time** is the amount of time over which the detector will collect light. The higher the integration time, the higher the total peak counts will be. The detector generally is most sensitive with counts around 40,000; however, other factors such as reference peak intensity and lamp power may affect this.

Set Scans to Average
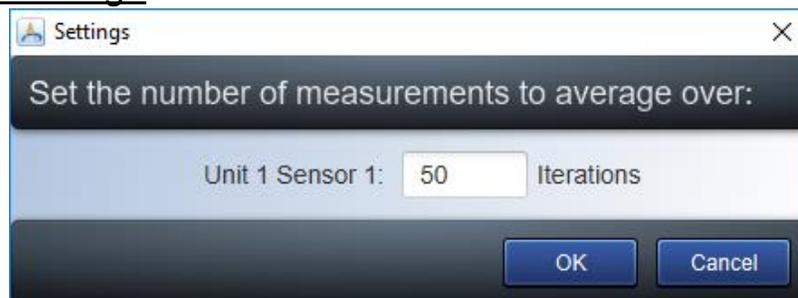
The **Scans to Average** is used to increase statistics for the measurement and improve the signal to noise; however, increasing the number of scans will also increase the data acquisition time. Users should balance the number of scans with the rate at which the processes are being monitored (sampling rate).

Set Shutter Ratio
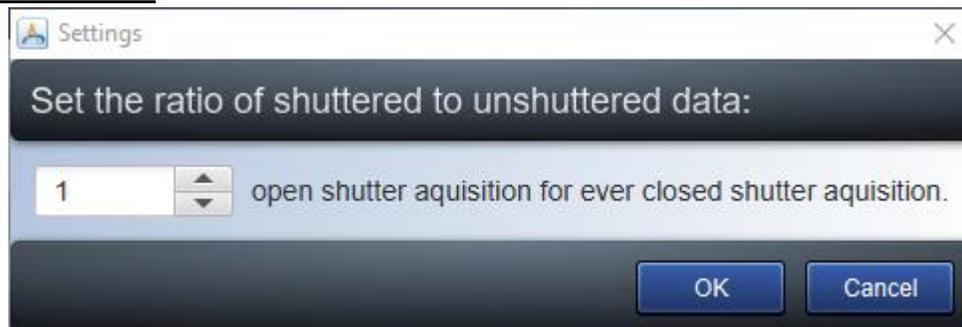
Shutter Ratio is the number of times a reference read will be reused. A setting of 1 will take a new reference reading for every measurement. This is the recommended setting and should only be changed

Select Chambers

The AtOMS system can support up to 3 sensors. In some cases, not all sensors are needed. This menu option allows users to select which sensors will be measured. The channel number corresponds to the ports on the back of the AtOMS system.

Serial Communication

The AtOMS allows for communication via RS232 serial connector. The communication allows for control of the system as well as receiving calculated values from the system.
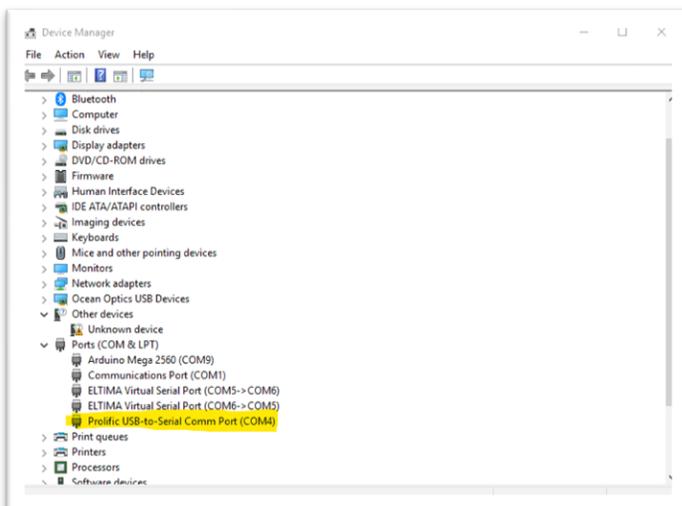
Hardware Setup

To configure the AtOMS hardware to support RS232 communicate, first plug the USB-to-RS232 converter into the AtOMS USB port on the front of the system. The system supports either USB port. The other USB port will be used for a keyboard/mouse pair. The RS232 can be removed at any time to accommodate the USB memory stick for file transfers.

Once the converter is plugged in, the correct COM port that was detected by windows must be determined. If it is unclear which COM port is being used, right click on the Windows button on the bottom left and select "Device Manager". Under the list of hardware select "Ports (COM & LPT). Here you will find the list of available COM port devices. There will be at least 2 COM devices. The "Arduino Mega 2560" is the AtOMS control board. The COM port labeled as USB-to-Serial Comm Port will be the COM port for the RS232.

Software Setup

To configure the software for using the external communication, first go to "Communication Settings" under the "System" menu. This will bring up the settings panel. The settings panel will allow the user to set the Baud Rate and COM port for the external communication. The communication port list is auto-populated with the currently available ports, so the RS232 to USB converted must be plugged in prior to setting the COM port. The system assumes the following parameters:

Bits	8
Stop Bits	1
Parity	None

Communication Protocols

This section covers how to communicate with the AtOMS system and how to receive information from an external source. All communication is String based to provide a simple mechanism for communication.

Outputs

The system sends out a double value that is the last calculated absorption value followed by an carriage return and an end line. For example:

96.8/r/n

This would mean that the last Absorption reading was 96.8%.

Inputs

AtOMS provides external communication signals that can be used to control the status of the system. The following table lists all current communication capabilities:

Command	Parameter	Suffix	Effect	Button
Reference		/r/n	Take Reference	
Recording	(on/off)	/r/n	Toggle Recording	
Reading	(on/off)	/r/n	Toggle Reading	

For example:

Record on/r/n

Would start recording data. Stopping recording with "Recording off/r/n" will automatically save the data to the default location without any file suffix.

About

The About menu is used to identify critical versioning information about the software. To ensure that updates have been correctly implemented, use the Version number.

Contact
Support:

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