



## Maya LSL Low Stray Light Spectrometer

### Installation and Operation Manual

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For Products: Maya LSL  
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A HALMA COMPANY

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# About This Manual

## Document Purpose and Intended Audience

This document provides the user of a Maya LSL Spectrometer with instructions for setting up, calibrating and performing experiments with their spectrometer.

## What's New in this Document

This version of the *Maya LSL Installation and Operation Manual* the specifications.

## Document Summary

Chapter	Description
Chapter 1: <a href="#">Introduction</a>	Contains descriptive information about the Maya LSL Spectrometer and how sampling works. It also provides a list of system requirements, interface options, and shipment components.
Chapter 2: <a href="#">Installing the Maya LSL</a>	Provides installation and configuration instructions.
Chapter 3: <a href="#">Troubleshooting</a>	Contains recommended steps to isolate and correct common problems.
Appendix A: <a href="#">Calibrating the Wavelength of the Maya LSL</a>	Provides instructions for calibrating the Maya LSL Spectrometer.
Appendix B: <a href="#">Specifications</a>	Contains technical specifications and connector pinouts for the Maya LSL Spectrometer.

## Product-Related Documentation

You can access documentation for Ocean Optics products by visiting our website at <http://www.oceanoptics.com>. Select *Technical* → *Operating Instructions*, then choose the appropriate document from the available drop-down lists. Or, use the **Search by Model Number** field at the bottom of the web page.

- Detailed instructions for OceanView Spectrometer Operating Software are located at: <http://www.oceanoptics.com/technical/OceanViewI&O.pdf>.
- Detailed instructions for the Breakout Box are located at: [http://www.oceanoptics.com/technical/HR4\\_breakout.pdf](http://www.oceanoptics.com/technical/HR4_breakout.pdf)

- Detailed instructions for external triggering are located at:  
<http://www.oceanoptics.com/technical/external-triggering2.pdf>.

Engineering-level documentation is located on our website at *Technical* → *Engineering Docs*.

You can also access operating instructions for Ocean Optics products from the *Software and Technical Resources* CD that ships with the product.

## Upgrades

Occasionally, you may find that you need Ocean Optics to make a change or an upgrade to your system. To facilitate these changes, you must first contact Customer Support and obtain a Return Merchandise Authorization (RMA) number. Please contact Ocean Optics for specific instructions when returning a product.

## Warranty

Our 3-Year Warranty covers Ocean Optics miniature fiber optic spectrometers, light sources and sampling accessories – regardless of the application – from manufacturing defects. It also covers fibers and probes for a full 12 months: <http://oceanoptics.com/services/exclusive-3-year-warranty/>.

This comprehensive warranty ensures you of the highest level of craftsmanship and reliability for years to come. No other manufacturer offers such a solid guarantee of quality and reliability.

The Ocean Optics 3-Year Warranty applies to Ocean Optics equipment (excluding OEM configurations) purchased on or after July 1, 2010. The warranty covers parts and labor needed to repair manufacturing defects that occur during the warranty period. We also will cover the costs of shipping warranty-related repairs from our customers to Ocean Optics and from us to our customers.

## ISO Certification

Ocean Optics, the industry leader in miniature photonics, has been certified for ISO 9001:2008 certification applicable to the design and manufacture of electro-optical equipment since 2009.

# Compliance

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## **WARNING**

**This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.**

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## **FCC COMPLIANCE**

**This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which the user will be required to correct the interference at his on expense.**

**WARNING:** The authority to operate this equipment is conditioned by the requirement that no modifications will be made to the equipment unless the changes or modifications are expressly approved by the manufacturer.

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## Chapter 1

# Introduction

## Product Overview

The Ocean Optics Maya LSL Low Stray Light Spectrometer combines the low straylight optical system of the Torus bench with a high sensitivity detector of the Maya Series spectrometers to offer fast and accurate scientific measurements in the visible region such as process measurements of color (with an accuracy of better than 2 MacAdam ellipse units), fluorescence and Raman. The Maya LSL features a new order-sorting filter that provides a 5% increase in light throughput and a larger aperture (f/3) to increase throughput by more than 50%. The wavelength range is 360 – 825 nm. Grating changes are possible to access the UV region.



### Ocean Optics Maya LSL Fiber Optic Spectrometer

The Maya LSL Spectrometer features the Hamamatsu FFT-CCD back-thinned detector, which offers excellent performance characteristics. Because of their great native UV-response, FFT-CCD detectors do not require UV-sensitive coatings, eliminating batch-to-batch variations. Other performance advantages of this detector include great signal-to-noise characteristics, low dark current and good signal processing speed.

The Maya LSL has 8 user-programmable digital I/O lines for interfacing to other equipment and a pulse generator for triggering other devices. You can use the I/Os to flash a lamp, stop/start a process, and send a message/alarm during the spectrometer's integration period. The spectrometer's operating parameters can be controlled through software. In fact, wavelength calibration coefficients unique to each spectrometer are programmed into a memory chip right on the spectrometer.

The Maya LSL high-speed electronics have been designed for considerable flexibility in connecting to various modules and external interfaces, including PCs, PLCs and other embedded controllers, through USB 2.0 or RS-232 communications. Its USB 2.0 interface enables full spectral scans into memory every 8 milliseconds.

## Features

- Hamamatsu S10420 (Maya LSL)
  - Back-thinned for good UV sensitivity
  - MPP operation for low noise
- Spectrometer Design
  - Symmetrical Crossed Czerny Turner
  - 101mm focal length
  - 1 grating option (T1)
  - 5 slit widths, interchangeable
- Electrical Performance
  - 16 bit, 500KHz A/D converter
  - Integration time: 7.2 ms to 5 seconds
- Embedded microcontroller allows programmatic control of all operating parameters and standalone operation
  - USB 2.0 480Mbps (high-speed) & 12Mbps (full speed)
  - RS232 115KBaud
  - Multiple communication standards for digital accessories (SPI, I2C)
- Onboard Pulse Generator
  - 2 programmable strobe signals for triggering other devices
  - Software control of nearly all pulse parameters
- Onboard GPIO
  - 8 user-programmable digital I/Os
- EEPROM storage for
  - Wavelength Calibration Coefficients
  - Linearity Correction Coefficients
  - Absolute Irradiance Calibration (optional)
- Plug-n-play interface for PC applications
- 30-pin connector for interfacing to external products
- CE certification

# System Requirements

You can use the Maya LSL USB connectivity with any computer that meets the requirements for the spectrometer operating software being used (Windows XP/7/8 or Vista (32-bit only) Mac OS X and Linux). See [About OceanView Software](#).

## EEPROM Utilization

An EEPROM memory chip in each Maya LSL contains wavelength calibration coefficients, linearity coefficients, and a serial number unique to each individual spectrometer. The OOI software application reads these values directly from the spectrometer, enabling the ability to “hot-swap” spectrometers between computers without entering the spectrometer coefficients manually on each computer.

## About OceanView Software

OceanView is the latest generation of operating software for all Ocean Optics spectrometers. It is a completely modular, Java-based spectroscopy software platform that operates on Windows, Macintosh and Linux operating systems. The software can control any Ocean Optics USB spectrometer and device.

OceanView is a user-customizable, advanced acquisition and display program that provides a real-time interface to a variety of signal-processing functions. With OceanView, you have the ability to perform spectroscopic measurements (such as absorbance, reflectance, and emission), control all system parameters, collect and display data in real time, and perform reference monitoring and time acquisition experiments. Consult the OceanView manual for hardware requirements when using OceanView (see [Product-Related](#) Documentation).

## Sampling System Overview

### How Sampling Works

Ocean Optics components function in a sampling system as follows:

1. The user stores reference and dark measurements to correct for instrument response variables.
2. The light transmits through an optical fiber to the sample.
3. The light interacts with the sample.
4. Another optical fiber collects and transmits the result of the interaction to the spectrometer.
5. The spectrometer measures the amount of light and transforms the data collected by the spectrometer into digital information.
6. The spectrometer passes the sample information to the spectrometer operating software.
7. The software compares the sample to the reference measurement and displays processed spectral information.

## Modular Sampling Accessories

Ocean Optics offers a complete line of spectroscopic accessories for use with the Maya LSL. Most of our spectroscopic accessories have SMA connectors for application flexibility. Accordingly, changing the sampling system components is as easy as unscrewing a connector and replacing an accessory.

## Interface Options

The Maya LSL has a USB connector, enabling you to connect the spectrometer to a desktop or notebook computer via a USB port. OceanView software is available to operate your spectrometer for an additional charge.

Computer Interface	Operating System Requirements	Part Needed	Description of Part
Computer via USB Port	OceanView: Windows XP/7/8 or Vista (32-bit only) for PC, OS X version 10.5 Intel or later for Mac, or any version released for an x86 or amd64 platform since 2010 for Linux	USB-CBL-1 (included)	Cable that connects from USB port on Maya LSL to USB port on desktop or notebook PC
Desktop or Notebook PC via Serial Port	Any 32-bit or 64-bit Windows operating system	HR4-BREAKOUT (not included)	Adapter block that enables connection from serial port on Maya LSL to serial port on desktop or notebook PC; comes with 5 VDC power supply (required when connecting to serial port)

## Shipment Components

- ❑ Maya LSL Spectrometer

The following information and documentation also ships with the Maya LSL Spectrometer:

- ❑ **Packing List**

The packing list is inside a plastic bag attached to the outside of the shipment box (the invoice arrives separately). It lists all items in the order, including customized components in the spectrometer (such as the grating, detector collection lens, and slit). The packing list also includes the shipping and billing addresses, as well as any items on back order.

- ❑ **Wavelength Calibration Data Sheet**

Each spectrometer is shipped with a Wavelength Calibration Data Sheet that contains information unique to your spectrometer. Your spectrometer operating software reads this calibration data from your spectrometer when it interfaces to a computer via the USB port.

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### Note

Please save the Wavelength Calibration Data Sheet for future reference.

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## Other Accessories Available

Visit us at [www.OceanOptics.com](http://www.OceanOptics.com) for a complete list of products available for all of your spectroscopy needs.

- ❑ **Fibers**
- ❑ **Light Sources**
- ❑ **Integrated Sampling Systems**
- ❑ **Cuvettes**
- ❑ **Filter Holders**
- ❑ **HR4-BREAKOUT Breakout Box**

## Breakout Box

Ocean Optics also offers the Breakout Box (HR4-BREAKOUT), a passive module that separates the signals from their 30-pin port to an array of standard connectors and headers, enabling easy access to a variety of features found in Ocean Optics' Maya LSL Spectrometer. In addition to the accessory connector, the breakout box features a circuit board based on a neutral breadboard pattern that allows custom circuitry to be prototyped on the board itself.

# Installing the Maya LSL Spectrometer

## Overview

You must install the operating software application prior to connecting your Maya LSL Spectrometer to a computer. The Ocean Optics spectrometer operating software installs the drivers required for the Maya LSL spectrometer installation. If you do not install the software first, the system will not properly recognize the Maya LSL.

If you have already connected the Maya LSL to the computer prior to installing the operating software, consult *Chapter 3: [Troubleshooting](#)* for information on correcting a corrupt Maya LSL installation.

## Maya LSL Installation

This section contains instructions for connecting the Maya LSL Spectrometer to a computer. To connect the Maya LSL Spectrometer to a computer via the USB port, the computer must be running a Windows XP/7/8 or Vista (32-bit), Mac OS X or Linux operating system.

### ► **Procedure**

Follow the steps below to connect the Maya LSL to a computer via the USB port:

1. Install the spectrometer operating software on the destination computer.
2. Locate the USB cable (USB-CBL-1) provided with the Maya LSL Spectrometer.
3. Insert the square end of the cable into the side of the spectrometer.
4. Insert the rectangular end of the cable into the USB port of the computer.

If you installed the spectrometer operating software prior to connecting the spectrometer, the software installs the spectrometer drivers. If the drivers do not successfully install (or if you connected the spectrometer to the computer before installing the software), consult *Chapter 3: [Troubleshooting](#)*.

If you have followed the previous steps and started the spectrometer operating software, the spectrometer is already acquiring data.

Once you install the software and hardware, and establish your sampling system, you are ready to take measurements.

# Connect Spectroscopic Accessories

To find operating instructions for Maya LSL-compatible products (such as light sources, sampling chambers, and probes), consult the Ocean Optics website at

<http://www.oceanoptics.com/technical/operatinginstructions.asp>.

## External Triggering Options

You can trigger the Maya LSL using a variety of External Triggering options through the 30-pin Accessory Connector on the spectrometer. See the External Triggering Options document located at [http://oceanoptics.com/wp-content/uploads/External-Triggering-Options\\_Firmware3.0andAbove.pdf](http://oceanoptics.com/wp-content/uploads/External-Triggering-Options_Firmware3.0andAbove.pdf). The triggering document contains instructions for configuring External Triggering options for the Maya LSL.

## Change the Slit

There's no need to calibrate your spectrometer when changing the slit, just install and start measuring. There is one exception to this. You cannot change from a standard slit to a slit with a filter because it changes the optical focus and wavelength calibration of the spectrometer. In this case you would need to send the spectrometer back to Ocean Optics. A filter must be ordered for each slit (if your application requires a filter) and the spectrometer needs to be calibrated and focused with the filter installed. This only applies to filters installed inside the slit assembly.

### ► Procedure

1. Find the SMA connector. If a fiber is attached, remove it.



2. Use the Allen key to remove the 2 the screws attaching the slit to the spectrometer.
3. Pull the slit out of the spectrometer.

## 2: Installing the Maya LSL

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4. Put the new INTSMA slit connector into the spectrometer; with the key of the connector on the left side.



5. Install the 2 screws again. Use the Allen key to tighten the screws carefully (do not over-tighten).
6. If necessary, connect the fiber again.



# Troubleshooting

## Overview

The following sections contain information on troubleshooting issues you may encounter when using the Maya LSL Spectrometer.

## Maya LSL Connected to Computer Prior to Software Installation

### Windows Operating Systems

If you connected your Ocean Optics USB device to the computer prior to installing your Ocean Optics spectrometer operating software application on a Windows platform, you may encounter installation issues that you must correct before your Ocean Optics device will operate properly.

Follow the applicable steps below to remove the incorrectly installed device, device driver, and installation files.

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#### Note

If these procedures do not correct your device driver problem, you must obtain the *Correcting Device Driver Issues* document from the Ocean Optics website: <http://www.oceanoptics.com/technical/engineering/correctingdevicedriverissues.pdf>.

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### Remove the Unknown Device from Windows Device Manager

#### ► Procedure

1. Open Windows Device Manager. Consult the Windows operating instructions for your computer for directions, if needed.
2. Locate the **Other Devices** option and expand the **Other Devices** selection by clicking on the "+" sign to the immediate left.

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### Note

Improperly installed USB devices can also appear under the Universal Serial Bus Controller option. Be sure to check this location if you cannot locate the unknown device.

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3. Locate the unknown device (marked with a large question mark). Right-click on the **Unknown Device** listing and select the **Uninstall** or **Remove** option.
4. Click the **OK** button to continue. A warning box appears confirming the removal of the Unknown Device. Click the **OK** button to confirm the device removal.
5. Disconnect the Maya LSL from your computer.
6. Replug the spectrometer into your computer.

The system should now be able to locate and install the correct drivers for the USB device.

## Mac Operating Systems

Since there are no device files for the Maya LSL Spectrometer in a Mac operating system, you should not encounter any problems if you installed the spectrometer before the software.

## Linux Operating Systems

For Linux operating systems, all you need to do is install the OceanView software, then unplug and replug in the spectrometer. Technically, the driver files for Linux simply give nonprivileged users permission to use newly connected hardware. There isn't any long-term harm to plugging in the device before installing the software.

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## Appendix A

# Calibrating the Wavelength of the Maya LSL Spectrometer

## Overview

This appendix describes how to calibrate the wavelength of your spectrometer. Though each spectrometer is calibrated before it leaves Ocean Optics, the wavelength for all spectrometers will drift slightly as a function of time and environmental conditions. Ocean Optics recommends periodically recalibrating the Maya LSL.

## About Wavelength Calibration

You are going to be solving the following equation, which shows that the relationship between pixel number and wavelength is a third-order polynomial:

$$\lambda_p = I + C_1p + C_2p^2 + C_3p^3$$

Where:

$\lambda$  = the wavelength of pixel  $p$

$I$  = the wavelength of pixel 0

$C_1$  = the first coefficient (nm/pixel)

$C_2$  = the second coefficient (nm/pixel<sup>2</sup>)

$C_3$  = the third coefficient (nm/pixel<sup>3</sup>)

You will be calculating the value for  $I$  and the three  $C$ s.

# Calibrating the Spectrometer

## Preparing for Calibration

To recalibrate the wavelength of your spectrometer, you need the following components:

- A light source capable of producing spectral lines

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### Note

Ocean Optics' HG-1 Mercury-Argon lamp is ideal for recalibration. If you do not have an HG-1, you need a light source that produces several (at least 4-6) spectral lines in the wavelength region of your spectrometer.

- A Maya LSL spectrometer
- An optical fiber (for spectrometers without a built-in slit, a 50- $\mu\text{m}$  fiber works best)
- A spreadsheet program (Excel or Quattro Pro, for example) or a calculator that performs third-order linear regressions

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### Note

If you are using Microsoft Excel, choose **Tools | Add-Ins** and check **AnalysisToolPak** and **AnalysisToolPak-VBA**.

## Calibrating the Wavelength of the Spectrometer

### ► Procedure

Perform the steps below to calibrate the wavelength of the spectrometer:

1. Place OceanView into Quick View mode and take a spectrum of your light source. Adjust the integration time (or the A/D conversion frequency) until there are several peaks on the screen that are not off-scale.
2. Move the cursor to one of the peaks and position the cursor so that it is at the point of maximum intensity.
3. Record the pixel number that is displayed in the status bar or legend (located beneath the graph). Repeat this step for all of the peaks in your spectrum.
4. Use the spreadsheet program or calculator to create a table like the one shown in the following figure. In the first column, place the exact or true wavelength of the spectral lines that you used.

In the second column of this worksheet, place the observed pixel number. In the third column, calculate the pixel number squared, and in the fourth column, calculate the pixel number cubed.

Independent Variable	Dependent Variables			Values Computed from the Regression Output	
True Wavelength (nm)	Pixel #	Pixel # <sup>2</sup>	Pixel # <sup>3</sup>	Predicted Wavelength	Difference
253.65	175	30625	5359375	253.56	0.09
296.73	296	87616	25934336	296.72	0.01
302.15	312	97344	30371328	302.40	-0.25
313.16	342	116964	40001688	313.02	0.13
334.15	402	161604	64964808	334.19	-0.05
365.02	490	240100	117649000	365.05	-0.04
404.66	604	364816	220348864	404.67	-0.01
407.78	613	375769	230346397	407.78	0.00
435.84	694	481636	334255384	435.65	0.19
546.07	1022	1044484	1067462648	546.13	-0.06
576.96	1116	1245456	1389928896	577.05	-0.09
579.07	1122	1258884	1412467848	579.01	0.06
696.54	1491	2223081	3314613771	696.70	-0.15
706.72	1523	2319529	3532642667	706.62	0.10
727.29	1590	2528100	4019679000	727.24	0.06
738.40	1627	2647129	4306878883	738.53	-0.13
751.47	1669	2785561	4649101309	751.27	0.19

- Use the spreadsheet or calculator to calculate the wavelength calibration coefficients. In the spreadsheet program, find the functions to perform linear regressions.
  - If using Quattro Pro, look under **Tools | Advanced Math**
  - If using Excel, look under **Analysis ToolPak**
- Select the true wavelength as the dependent variable (Y). Select the pixel number, pixel number squared, and the pixel number cubed as the independent variables (X). After executing the regression, you will obtain an output similar to the one shown below. Numbers of importance are noted.

**Regression Statistics**

Multiple R 0.999999831  
 R Square 0.999999663 ← R Squared  
 Adjusted R Square 0.999999607  
 Standard Error 0.125540214  
 Observations 22

	<u>Coefficients</u>	<u>Standard Error</u>	
Intercept	190.473993	0.369047536	← First coefficient
X Variable 1	0.36263983	0.001684745	←
X Variable 2	-1.174416E-05	8.35279E-07	← Second coefficient
X Variable 3	-2.523787E-09	2.656608E-10	← Third coefficient

7. Record the Intercept, as well as the First, Second, and Third Coefficients. Additionally, look at the value for R squared. It should be very close to 1. If not, you have most likely assigned one of your wavelengths incorrectly.

Keep these values at hand.

## Saving the New Calibration Coefficients: USB Mode

Ocean Optics programs wavelength calibration coefficients unique to each Maya LSL Spectrometer onto an EEPROM memory chip in the spectrometer.

You can overwrite old calibration coefficients on the EEPROM using the Maya LSL Spectrometer via the USB port.

### ► Procedure

To save wavelength calibration coefficients using the USB mode, perform the following steps:

1. Ensure that the Maya LSL is connected to the PC and that you have closed all other applications.
2. Point your browser to <http://www.oceanoptics.com/technical/softwaredownloads.asp> and scroll down to **Microcode**. Select **USB EEPROM Programmer**.
3. Save the setup file to your computer.
4. Run the **Setup.exe** file to install the software. The **Welcome** screen appears.
5. Click the **Next** button. The **Destination Location** screen appears.
6. Accept the default installation location, or click the **Browse** button to specify a directory. Then, click the **Next** button. The **Program Manager Group** screen appears.
7. Click the **Next** button. The **Start Installation** screen appears.
8. Click the **Next** button to begin the installation. Once the installation finishes, the **Installation Complete** screen appears.
9. Click the **Finish** button and reboot the computer when prompted.
10. Navigate to the **USB EEPROM Programmer** from the Start menu and run the software.
11. Click on the desired spectrometer displayed in the left pane of the **USB Programmer** screen.
12. Double-click on each of the calibration coefficients displayed in the right pane of the USB Programmer screen and enter the new values acquired in Steps 5 and 6 of the [Calibrating the Wavelength of the Spectrometer](#) section in this appendix.
13. Repeat Step 12 for all of the new values.
14. Click on the **Save All Values** button to save the information, and then **Exit** the USB Programmer software.

The new wavelength calibration coefficients are now loaded onto the EEPROM memory chip on the Maya LSL Spectrometer.

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# Appendix B

# Specifications

## Overview

This appendix contains information on spectrometer specifications.

## Maya LSL Spectrometer Specifications

The following sections provide specification information for the CCD detector in the Maya LSL spectrometer, as well as for each model Maya LSL Spectrometer itself.

### CCD Detector Specifications

Specification	Value
Detector	Hamamatsu S10420, back-thinned FFT-CCD
Thermoelectric cooling	No
Number of pixels	All: 2068 x 70 Active: 2048 x 64
Spectral range	200-1100
Pixel size	14 $\mu\text{m}$ square
Pixel well depth	200 Ke-
Column height	896 $\mu\text{m}$ square
Detector active area (mm)	28.672 horizontal x 0.896 vertical

## Maya LSL Spectrometer Specifications

Specification	Value
Dimensions (LxWxH)	151 mm (5.94 in.) x 151 mm (5.94 in.) x 65 mm (2.56 in.)
Weight	1.91 kg (4.21 lbs.)
Temperature Operation Storage	-0 °C to +50 °C -30 °C to +70 °C
Humidity	0 – 90% noncondensing
Power consumption	500 mA @ 5 VDC
Supply Voltage	4.5 – 5.5 V
Power-up Time	~ 2s depending on code size
Gratings	1 grating available (T1)
Entrance aperture	5, 10, 25, 50, or 100 µm wide slits
Focal length (input)	f/3 101.6 mm
Wavelength range	360 – 825 nm
Optical resolution (FWHM)	<1.6 nm full range
A/D converter	16 bit, 150 kHz+
Dynamic range	15K:1 (typical)
Signal-to-noise ratio	450:1
Fiber optic connector	SMA 905 to single-strand optical fiber (0.22 NA)
Integration time	7.2 ms to 5 seconds
Interfaces	USB 2.0; RS-232 (3-wire)



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