Operating Manual and User's Guide

USB2000 Miniature Fiber Optic Spectrometers and Accessories

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Introduction

Ocean Optics miniature fiber optic spectrometers and accessories have revolutionized the analytical instrumentation market by dramatically reducing the size and cost of optical sensing systems. More than 15,000 Ocean Optics spectrometers have been sold worldwide -- striking evidence of the far-reaching impact of low-cost, miniature components for fiber optic spectroscopy. Diverse fields such as research and development, industrial process control, medical diagnostics and environmental monitoring have benefited from access to Ocean Optics technology.

In the Beginning

Ocean Optics began in 1989 when Florida university researchers developed a fiber optic pH sensor as part of an instrument designed to study the role of the oceans in global warming. They soon formed Ocean Optics, Inc. and their ingenious work earned a Small Business Innovation Research (SBIR) grant from the U.S. Department of Energy. While designing the pH-monitoring instrument, the researchers wanted to incorporate with their sensor a spectrometer small enough to fit onto a buoy and were surprised to discover none existed. So they built their own. In 1992, the founders of Ocean Optics revolutionized the analytical instrumentation market, filled a substantial need in the research community, and changed the science of spectroscopy forever by creating a breakthrough technology: a miniature fiber optic spectrometer nearly a thousand times smaller and ten times less expensive than previous systems.

By April 1992, just thirty days after the successful completion of Phase II of the SBIR grant, Ocean Optics, Inc. introduced the S1000 -- "The World's First Miniature Fiber Optic Spectrometer." Due to this dramatic reduction in size and cost of optical sensing systems, applications once deemed too costly or technologically impractical using conventional spectrometers were not only feasible, but practical.

S2000 Miniature Fiber Optic Spectrometer

Our second-generation miniature fiber optic spectrometer, the S2000, couples a low-cost, high-performance 2048-element linear CCD-array detector with an optical bench that's small enough to fit into the palm of your hand. The S2000 accepts light energy transmitted through optical fiber and disperses it via a fixed grating across the detector. The S2000 must communicate with a PC via an external analog-to-digital (A/D) converter, which can sometimes be problematic if a PC is connected to several devices. In an effort to fill a need among our users -- hassle-free instrument-to-PC interfacing -- we created a fully plug-and-play spectrometer.

USB2000 Miniature Fiber Optic Spectrometer

The USB2000 Miniature Fiber Optic Spectrometer is a small-footprint (about the size of a deck of cards), plug-and-play version of our revolutionary S2000 Miniature Fiber Optic Spectrometer. The USB2000 plugs into a USB port of any desktop or notebook PC, eliminating the need for external A/D converters. Wavelength calibration coefficients unique to each spectrometer are programmed into a memory chip right on the USB2000; OOIBase32 software simply reads these values from the spectrometer. What's more, the USB2000 does not require an external power supply; it draws its power from the computer. Just as with all other Ocean Optics user-configured spectrometers, users select from 14 gratings, 6 slits and hundreds of fiber optic accessories such as light sources, probes and optical fibers to create the system just right for their application.

The Modular Approach

A typical USB2000 small-footprint system comprises four basic elements: the USB2000 Miniature Fiber Optic Spectrometer, our operating software, a light or excitation source, and sampling optics. The light or excitation source sends light through an optical fiber to the sample. The light interacts with the sample. Then the light is

collected and transmitted through another optical fiber to the spectrometer. The spectrometer measures the amount of light and transforms the data collected by the spectrometer into digital information that is passed to spectrometer operating software on the user's PC.

The software used to collect and display data from the USB2000 is OOIBase32 Spectrometer Operating Software, our latest generation of operating software for all Ocean Optics spectrometers. OOIBase32, free to all customers, is a 32-bit, user-customizable, advanced acquisition and display program that provides a real-time interface to a variety of signal-processing functions. With OOIBase32, 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.

We also offer a complete line of spectroscopic accessories to use with the USB2000. Most accessories have SMA connectors for application flexibility. Changing the sampling system is as easy as unscrewing a connector and adding a new component or accessory. A partial list of Ocean Optics spectroscopic accessories includes light sources, sampling holders, filter holders, flow cells, fiber optic probes and sensors, collimating lenses, attenuators, diffuse reflectance standards, integrating spheres and an extensive line of optical fibers. The USB-ISS-VIS, which is a light source/cuvette holder combo, and the USB-FHS, a filter holder, are two snap-on, direct-attach accessories created just for the USB2000.

This modular approach -- components are easily mixed and matched -- offers remarkable applications flexibility. Users pick and choose from hundreds of products to create distinctive systems for an almost endless variety of optical-sensing applications. Just a few of the applications requiring our systems follows.

Field	Applications Requiring Ocean Optics Systems
Medical and Life Sciences	Noninvasive medical diagnostics such as optical biopsy, blood analysis, glucose monitoring and cancer detection
Process and Quality Control	Pharmaceutical processing and dissolution monitoring, color calibration and food processing; and techniques in the oil, gas, chemical, paper, polymer and textile industries
Environmental Monitoring	Ocean monitoring, hazardous site evaluation, water treatment, air pollution control, stack emissions, ozone depletion, and soil and water contamination analysis
Semiconductor Technologies	Plasma diagnostics, end-point detection and thin film thickness
Research and Education	Scientific research and teaching aid
Astronomy/Aerospace	Emission of celestial bodies and burn efficiency and flame analysis of re-entry rockets
Consumer Analytical	Consumer-based and quality control applications in the automotive, cosmetic, home diagnostic, coating, paint and gemology industries

With Your Spectrometer Shipment

With your USB2000 shipment, you are sent important information and documentation regarding your shipment and spectrometer. They include the following:

Packing List

A packing list comes with your order. It is located inside a plastic bag attached to the outside of the shipment box. The invoice is mailed separately. The items listed on your packing slip include all of the components in your order, some of which are items you have specified to be installed *into* your spectrometer, such as the grating, detector collection lens and slit. The packing list also includes important information such as the shipping and billing addresses as well as components on back order. What you won't find on the packing list is OOIBase32, the free operating software that comes with every spectrometer order.

Wavelength Calibration Data Sheet and File

Your spectrometer is shipped in a silver-gray anti-static bag. Also inside this bag is a Wavelength Calibration Data Sheet wrapped around a Spectrometer Configuration diskette. The information on the Data Sheet and in the file on the diskette is identical and unique to your spectrometer. When you install OOIBase32 Spectrometer Operating Software onto a PC, you are prompted to insert this diskette into your computer. OOIBase32 will read the data on the diskette so that the user won't have to enter the data manually. For all other Ocean Optics software, you are required to type in the information from the Data Sheet into a specific dialog box in the software, so retaining the Data Sheet is necessary.

***Software and Resources Library* CD**

Your spectrometer order comes with our *Software and Resources Library* CD. It contains all Ocean Optics software and manuals for operating our software, spectrometers, and spectroscopic accessories. All manuals and operating instructions on the CD are in Portable Document Format (PDF), which means that you need to have Adobe Acrobat Reader to view them. We have included Adobe Acrobat Reader 4.0 on the CD and we recommend installing it on your PC for the finest viewing quality.

Except for OOIBase32 Spectrometer Operating Software, all Ocean Optics software is password protected. If you purchased application software, such as irradiance or color measurement software, the password for the software can be found on the back of the *Software and Resources Library* CD jewel case.

In This Manual

This manual provides users with a ***Getting Started*** section that should get the user up and running. It includes directions on installing OOIBase32 Spectrometer Operating Software, interfacing the USB2000 to your computer, and connecting spectroscopic accessories. To find the pages in the manual for in-depth operating instructions on some of our most popular spectroscopic accessories including light sources, sampling chambers, sampling optics, probes and optical fibers, turn to the **Table of Contents**. We have also included an **Experiment Tutorial** section that provides directions on taking basic measurements. This manual, however, does not include directions on using OOIBase32 Spectrometer Operating Software. There is a separate manual for OOIBase32, which, just like the software, can be found on both our web site and the *Software and Resources Library* CD.

Upgrades

Customers sometimes find that they need Ocean Optics to make a change or an upgrade to their system. In order for Ocean Optics to make these changes, the customer must first contact us and obtain a Return Merchandise Authorization (RMA) number. Please contact an Ocean Optics Applications Scientist for specific instructions when returning a product.

Getting Started

The USB2000 is easy to set up, allowing the user to start collecting data within minutes. The pages in this section provide instructions on installing and configuring the software and interfacing the USB2000 to your PC. If you need step-by-step directions for using spectroscopic accessories, refer to the **Table of Contents** to find the correct page numbers. For detailed instructions on using OOIBase32, refer to the **OOIBase32 Spectrometer Operating Software Manual**, which can be found on the *Software and Resources Library* CD and our web site.

Inside the shipment box is a bubble-wrapped package. It contains the Wavelength Calibration Data Sheet wrapped around the Spectrometer Configuration diskette, the USB cable that connects the spectrometer to a PC and a static-shielded bag. Inside the silver static-shielded bag is the USB2000 spectrometer. You will need all of these to get started. At this point, the *Software and Resources Library* CD that comes with every Ocean Optics spectrometer order should be in your PC's CD drive.

Step 1: Install OOIBase32*

When you get your USB2000, you might be to tempted to connect the USB2000 to your PC before doing anything else. However, you must install the latest version of OOIBase32 Spectrometer Operating Software first.* Before installing OOIBase32, make sure that no other applications are running. From the *Software and Resources Library* CD, navigate to **Install OOIBase32**.

1. Execute **Setup.exe**. At the “Welcome” dialog box, click **Next>**.
2. At the “Destination Location” dialog box, accept the default or choose **Browse** to pick a directory. Click the **Next>** button.
3. At the “Backup Replaced Files” dialog box, select either **Yes** or **No**. We recommend selecting Yes. If you select Yes, you can choose **Browse** to pick a destination directory. Click **Next>**.
4. Select a Program Manager Group. Click **Next>**. At the “Start Installation” dialog box, click **Next>**.
5. Follow all prompts regarding the Spectrometer Configuration diskette that came with your system.
6. At the “Installation Complete” dialog box, choose **Finish>**.
7. When prompted to do so, **restart your computer** when the installation is complete.
8. Do not run OOIBase32 at this time.

* **If you connected the USB2000 to your PC *before* you installed OOIBase32, you will *NOT* be able to use your spectrometer. See page 6 for details on how to rectify an incorrect installation.**

Step 2: Connect the USB2000 to your PC

Now you may connect the USB2000 to your PC. Keep the *Software and Library Resources* CD in your PC's CD drive.

1. Find the USB cable that came with your shipment. Insert the square end of the cable into the side of the USB2000 spectrometer. Insert the other end into a USB port on your PC.
2. If you installed OOIBase32 correctly, an **Add New Hardware Wizard** message box appears telling you that the USB2000 has been successfully loaded.

Step 3: Configure OOIBase32

Navigate to the OOIBase32 icon and select it. You need to configure OOIBase32 before using the USB2000. (For details on using OOIBase32, refer to the **OOIBase32 Spectrometer Operating Software Manual**, which can be found on the *Software and Resources Library* CD and our web site.)

Operator and Serial Number Dialog Box

First, a prompt to enter a user name and software serial number appears. Some data files will include this information in the header.

Default Spectrometer Configuration File

Next, a message appears asking you to select a default spectrometer configuration file. Navigate to the OOIBase32 directory and choose the file with **.spec** as the extension. The **.spec** extension is preceded by the serial number of your spectrometer (**USB2E111.spec** is an example of a spectrometer configuration filename).

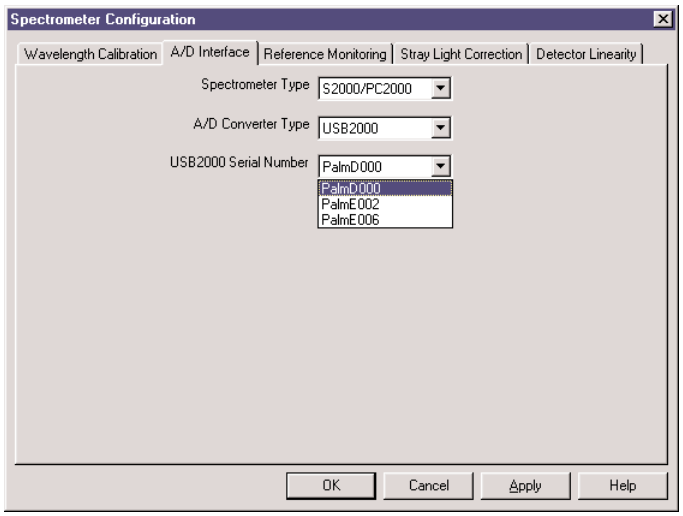
Configure Hardware Dialog Box

Next, the **Configure Hardware** dialog box opens. The parameters in this dialog box are usually set only once -- when OOIBase32 is first installed and the software first opens.

1. Next to Spectrometer Type, choose **S2000/PC2000**.
2. Next to A/D Type, choose **USB2000**.
3. Next to USB2000 Serial Number, choose your USB2000. These are the only parameters for your system.

Spectrometer Configuration Dialog Box

Select **Spectrometer | Configure** from the menu and set system parameters. In the **Wavelength Calibration** page, the coefficients for your system were loaded as part of the **.spec** file. Under **Spectrometer Channel**, make sure that both **Master** and the **Enabled** box are selected. In the **A/D Interface** page, enter the same values as you did in the **Configure Hardware** dialog box. When you exit OOIBase32, this data is stored in the the **.spec** file.



OOIBase32 Settings Dialog Box

Choose **Edit | Settings** from the menu to set OOIBase32 parameters in the **OOIBase32 Settings** dialog box. Go through this dialog box to select options for saving, opening, and printing data; to choose wav sound files for various program events; to configure default setting files; and to select other important options such as storing data, copying data and choosing warning messages.

Configure Data Acquisition Dialog Box

Finally, select **Spectrum | Configure Data Acquisition** from the menu to open the **Configure Data Acquisition** dialog box and to set your data acquisition parameters such as the integration time, averaging and boxcar smoothing, and several other parameters.

Step 4: Connect Spectroscopic Accessories

Most spectroscopic accessories will connect to the USB2000 via optical fiber. Two accessories, however, were created specifically for the USB2000. The USB-ISS-VIS visible light source/sampling chamber combo and the USB-FHS filter holder are snap-on, direct-attach accessories for the USB2000 and require no external power when connected to a USB2000 that is running off of a PC. To find detailed information on connecting and operating sampling optics such as light sources, sampling chambers, probes, fibers, or any other Ocean Optics spectroscopic accessory, check the **Table of Contents** for the correct page numbers specific to your accessories.

Step 5: Start OOIBase32 and Receive Data

Run OOIBase32 in Scope Mode and take a dark reference spectrum (see the **Experiment Tutorial** for details). Choose the absorbance, transmission, or relative irradiance mode to take your measurements. For detailed information on OOIBase32 functions and features, refer to the **OOIBase32 Spectrometer Operating Software Manual.**

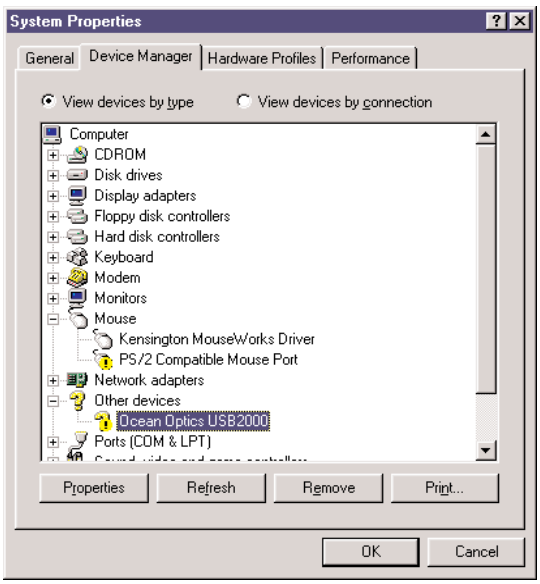
Your USB2000 can connect to any PC that 1) uses Windows 98/2000 Operating System and 2) has OOIBase32 installed and configured for use with your USB2000 spectrometer. If multiple PCs meet these two qualifications, you can switch your USB2000 among them. When you connect the USB2000 to any computer that has previously been set up properly and you open OOIBase32 software, you can receive data immediately.

Rectifying an Incorrect Installation

If you connected the USB2000 to your PC before you installed OOIBase32, you will not be able to use your spectrometer. You will receive an **Add New Hardware Wizard** message box as your computer tries to find the device driver necessary for it to interface to the USB2000. Ultimately, you will get a message that tells you that Windows has not installed a driver for the device. Also, if you have an older version of OOIBase32, you will have to uninstall it and install the latest version. To rectify an incorrect installation follow these steps:

If you connected USB2000 before installing OOIBase32

1. Navigate to your computer's Device Manager. For Windows 98 systems, right click on **My Computer**, select **Properties** and click on the **Device Manager** tab. For Windows 2000 systems, right click on **My Computer**, select **Properties**, select the **Hardware** tab and click on the **Device Manager** button.
2. Scroll down until you see **Other devices**. Select the "+" sign to the left of **Other devices**.
3. Under **Other devices**, you will see **Ocean Optics USB2000** next to a large question mark. Select **Ocean Optics USB2000**. Now select the **Remove** button at the bottom of the dialog box. Click **OK**.
4. A warning box asks if it is okay to remove the Ocean Optics USB2000 device from your system. Click **OK**.
5. Unplug your USB2000 from your PC. Follow the ***Getting Started*** directions starting with **Step 2: Connect the USB2000 to your PC** on page 4.



If you connected the USB2000 to a PC that has an older version of OOIBase32, follow the directions above (in the section, **If you connected USB2000 before installing OOIBase32**) and then follow the directions below (in the section, **If you have an older version of OOIBase32**).

If you have an older version of OOIBase32

If the PC you want to use to interface to your USB2000 already has an older version of OOIBase32, you must uninstall the older version of OOIBase32 and install the latest version of OOIBase32. No spectral data files will be lost during an uninstallation process.

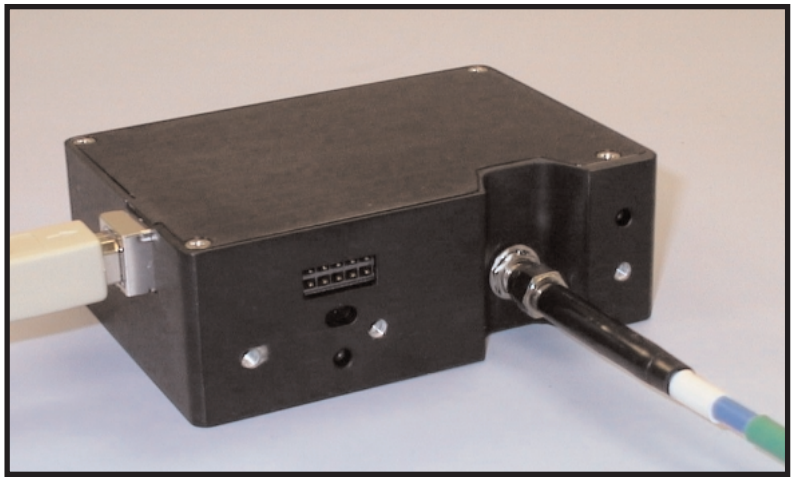
1. Select the Start button on your Windows task bar. Choose **Settings | Control Panel | Add/Remove Programs**.
2. Select OOIBase32 from the list.
3. For **Select Uninstall Method**, choose **Automatic** and click **Next>**.
4. For **Perform Rollback**, select **No** and click **Next>**. Click **Finish**. If prompted, restart your computer.
5. Follow the ***Getting Started*** directions starting with **Step 1: Install OOIBase32** on page 4.

USB2000 Miniature Fiber Optic Spectrometers

The USB2000 Miniature Fiber Optic Spectrometer is a small-footprint (about the size of a deck of cards), plug-and-play version of the company's revolutionary S2000 Miniature Fiber Optic Spectrometer. The USB2000 Spectrometer plugs into a USB port of any desktop or notebook PC, eliminating the need for external analog-to-digital (A/D) converters.

Ocean Optics spectrometers interface to PCs via A/D converters. Previously, the A/D converters we used were external -- they either had to be installed into PCs or connected to serial ports on PCs. For these A/D converters, the user had to execute several steps to configure their computer, the Ocean Optics software or the A/D converter in order for the spectrometer and the PC to communicate with one another.

Although this installation process was not difficult (as evidenced by the 15,000 spectrometers successfully installed out in the field), we wanted to offer a truly plug-and-play spectrometer. As a result, the USB2000 was created.



An USB2000 Miniature Fiber Optic Spectrometer with USB cable (at left) and optical fiber (at right).

Setting up the USB2000 Spectrometer is easy. The user only has to install the latest version of OOIBase32 Spectrometer Operating Software onto any desktop or notebook PC that has Windows 98 or 2000 operating system and then connect the USB cable from the spectrometer to the PC.

But the USB2000 is not a completely new spectrometer. When creating the USB2000, we made sure to incorporate the same features that distinguish all other Ocean Optics spectrometers -- such as small size, great flexibility, superior performance and low cost. Then we included additional benefits. Wavelength calibration coefficients and the spectrometer serial number are installed onto an EEPROM memory chip right on the spectrometer; OOIBase32 software simply reads these values from the spectrometer. And the USB2000 does not require an external power supply; it draws its power from the computer.

Just as with all other Ocean Optics user-configured spectrometers, users work with our Applications Scientists when selecting the USB2000 -- by choosing from 14 gratings, 6 slits and hundreds of fiber optic accessories such as light sources, probes and optical fibers -- to create the system just right for their application.

The USB2000 couples a low-cost, high-performance 2048-element linear CCD-array detector with an optical bench that's small enough to fit into the palm of your hand -- the same detector and optical bench that have provided great performance to the users of our 15,000 systems out in the field. The USB2000 also works the same as our other spectrometers in that it accepts light energy transmitted through single-strand optical fiber and disperses it via a fixed grating across the linear CCD array detector, which is responsive from 200-1100 nm.

Performance

Operating performance of the USB2000 varies according to a number of factors, including the spectrometer configuration -- especially the groove density of the grating and the size of the entrance optics -- as well as the application itself. Optical resolution, measured as Full Width Half Maximum (FWHM), of a monochromatic source depends on the groove density (lines/mm) of the grating and the diameter of the entrance optics (optical fiber or slit). The following formulas approximately calculate the optical resolution of your system in nm (FWHM).

DISPERSION (nm/pixel) = $\frac{\text{Spectral range of the grating}}{\text{2048 (number of pixels or detector elements)}}$

RESOLUTION (in pixels) = typical values from slit size or fiber diameter (see below)

5 µm slit = 3.0 pixels	50 µm slit = 6.5 pixels
10 µm slit = 3.2 pixels	100 µm slit = 12.0 pixels
25 µm slit = 4.2 pixels	200 µm slit = 24.0 pixels

OPTICAL RESOLUTION (in nm) = DISPERSION X RESOLUTION

Computer Compatibility

Below are the requirements necessary for your computer to communicate with the USB Spectrometer.

- IBM-compatible PC with Pentium or better microprocessor
- 32 MB RAM (16 MB)
- Windows 98 or Windows 2000 Operating System
- OOIBase32™ 32-bit Spectrometer Operating Software

To find out if your computer is USB ready and can work with the USB2000 Spectrometer, download and run a simple utility from the following ftp site: **ftp://ftp.oceanoptics.com/pub/usbready/usbready.exe**. After running the utility, you will either receive a message that **Yes**, your computer is USB ready, or that **No**, it is not USB ready.

USB2000 Pin Description

Listed below is the pin description for the USB2000 Accessory Connector (J2) located on the front vertical wall of the unit. (To order multiple mating connectors, contact Samtec, Inc. for item number IPS1-105-01-S-D. Visit Samtec's web site at www.samtec.com.)

Pin #	Description
1	V_{USB} or $5V_{in}$
2	RS232 Tx
3	RS232 Rx
4	Lamp Enable
5	Continuous Strobe
6	Ground
7	External Trigger In
8	Single Strobe
9	I^2C SCL
10	I^2C SDA

10	8	6	4	2
9	7	5	3	1

Diagram of Pins on the Accessory Connector

USB2000 Specifications

Physical Specifications

Physical Dimension	3.5” x 2.5”x 1.31” LWH 89 mm x 64 mm x 34 mm LWH
Weight	.45 lb without cable, .60 lb with cable 200 grams without cable, 270 grams with cable

Spectrometer

Optical Bench Design	asymmetric Cross Czerny-Turner optical bench
Detector	Sony ILX511 -- 2048-element, linear silicon CCD array
Gratings	multiple grating choices, optimized for UV, VIS or Shortwave NIR
Entrance Slit	width: 5, 10, 25, 50, 100, or 200 µm height: 1000 µm (Slits are optional. In the absence of a slit, the fiber acts as entrance slit.)
Input Fiber Connector	SMA 905
Focal Length	42 mm (input), 68 mm (output)
Optional Order Sorting Filters	long pass plug filters block second order effects, reduce signal intensity
Optional Order Sorting Coating	single-piece, detector coating for ~ 200-850 nm applications (available with grating #1 and #2 only) blocks second and third order effects
Optional UV Detector Upgrade	Quartz window at optical bench entrance allows transmission of UV light for applications <360 nm
Optional Collection Lens	Improves light-collection efficiency by ~5x (lens focuses tall slit images onto short detector pixels)

Performance

Integration Time	3 milliseconds to 65 seconds
Effective Range	200 - 1100 µm
Dynamic Range	2×10^{8}
Optical Resolution (FWHM)	0.3 – 10.0 nm FWHM (optical resolution varies according to grating and entrance aperture chosen)
Sensitivity	86 photons/count; 2.9×10^{-17} joule/count; 2.9×10^{-17} watts/count
Signal-to-Noise	250:1 -- single acquisition at full signal
Readout Noise (single dark spectrum)	3.5 counts RMS, 20 counts peak-to-peak
Stray Light	<0.05% at 600 nm; <0.10% at 435 nm, <0.10% at 250 nm

Absolute Maximum Ratings

Vcc	8.0V
Voltage (on any pin)	7.0V

Power

Power Requirement	0.5W (100 mA @ 5V)
Supply Voltage	3.9V - 8.0V

Environmental Conditions

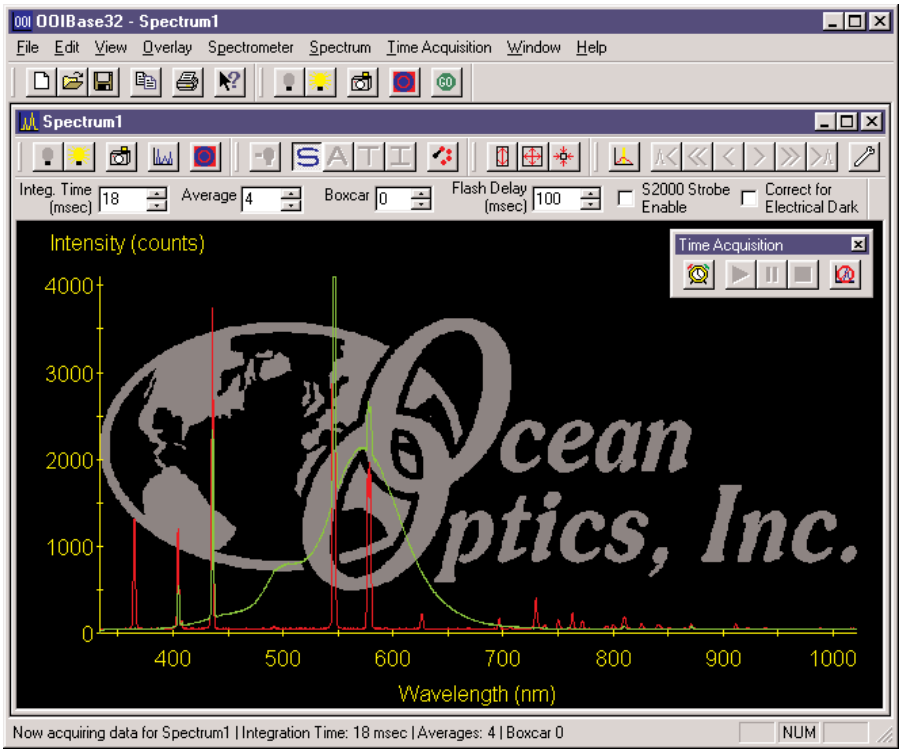
Temperature	-30° to +70° C Storage; 10° to +50° C Operation

OOIBase32 Spectrometer Operating Software

OOIBase32 Spectrometer Operating Software is our next generation of operating software for all Ocean Optics spectrometers. OOIBase32 is a 32-bit, user-customizable, advanced acquisition and display program that provides a real-time interface to a variety of signal-processing functions for Windows 95/98/00 and Windows NT users. With OOIBase32, you have the ability to perform spectroscopic measurements such as absorbance, reflectance and emission; control all system parameters; collect data from up to 6 USB2000 spectrometers and display the results; and perform reference monitoring and time acquisition experiments.

OOIBase32 allows you to perform the three basic spectroscopic experiments -- absorbance, reflectance and emission -- as well as signal-processing functions such as signal averaging, boxcar pixel smoothing, electrical dark-signal correction and stray light correction. Scope mode -- the OOIBase32 operating mode in which raw data (signal) is displayed -- allows you to establish these signal-conditioning parameters. The basic concept for the software is that real-time display of data allows you to evaluate the effectiveness of your experimental setup and data processing selections, make changes to these parameters, instantly see their effect, and save the data. Most spectrometer-system operating software does not allow such signal-conditioning flexibility.

With OOIBase32, you can even perform time acquisition experiments for kinetics applications. As part of the time acquisition function, you can monitor and report up to six single wavelengths and up to two mathematical combinations of these wavelengths. In addition, you can perform reference monitoring with just a one-channel system.



OOIBase32 gives you complete control of setting the parameters for all system functions such as acquiring data, designing the graph display, using spectra overlays, and configuring the cursor. You can also save and then retrieve all of these system parameters for future experiments. OOIBase32 has the benefit of giving you triggering options for external events such as the firing of a laser or the pulsing of a light source.

Other advanced features provide you with several data collection options. You have the ability to independently store and retrieve dark, reference, sample and processed spectra. All data can be saved to disk using autoincremented filenames. You can save data as ASCII files or in the native GRAMS/32 SPC format. One feature prints the spectra and another copies spectral or graphical data into other software such as Microsoft Excel and Word.

Other OOIBase32 extras include the ability to monitor the status bar for each spectral window, which reflects numerous parameters set by the user; manipulate the placement of an array of dockable toolbars; and choose sound cues for a variety of spectroscopic events. You can also designate how you receive data acquisition warnings such as when the scope mode signal has saturated in absorbance, transmission, and irradiance modes. In addition, the time normalization function allows you to designate separate integration times for reference and sample scans.

OOIBase32 is the latest edition of operating software for all Ocean Optics spectrometers. This change from 16-bit to 32-bit operating software reflects Ocean Optics' decision to upgrade its software to accommodate the increase of 32-bit operating systems. Additionally, OOIBase did not allow for multiple channels to be shown in one spectral window.

OOIBase32 still includes the functions of the original OOIBase, but numerous editing, viewing, and spectral processing functions have been added. The chart below outlines the significant changes from OOIBase to the new and improved OOIBase32.

OOIBase	**OOIBase32**
16-bit program	32-bit program
Supports single A/D card	Supports multiple A/D cards simultaneously
No overlays	Up to 8 overlays for each spectral window
All spectral windows must share the same acquisition parameters	Each spectral window can have separate acquisition parameters
Limited advanced spectral features	Comprehensive advanced spectral features (dual-beam reference, stray light and linearity correction, time acquisition)
Not customizable	Customizable
User-friendly	More user-friendly
No internal troubleshooting	Internal troubleshooting
Time series acquisition of full spectra	Time acquisition of both full spectra and discrete wavelengths
No time normalization	Time normalization

Ocean Optics also offers numerous add-on software programs for applications such as color and irradiance measurements, oxygen sensing, pharmaceutical dissolution testing, and Raman spectroscopy. You can also purchase device drivers and code for software development. Custom programming services are also available.

For detailed instructions on all of the features, menu items, and options in OOIBase32, please refer to the PDF version of the **OOIBase32 Spectrometer Operating Software Manual** on the ***Software and Resources Library*** CD.

Free OOIBase32 upgrades are available via our web site at www.OceanOptics.com.

Light Sources

Ocean Optics light sources provide illumination and excitation in the UV, VIS or Shortwave NIR range for absorbance, reflection and fluorescence measurements; discrete line spectra for wavelength calibrations; and calibrated absolute intensity standards for irradiance measurements. Wall transformers are supplied for laboratory use. Most of the light sources are powered by +12 VDC to facilitate their use in the field. Note that though some light sources emit energy <200 nm, or emit energy to 2 µm, their use with Ocean Optics spectrometers is limited by our detector's responsivity (200-1100 nm).

DT-1000

- The **MINI-D2T Miniature Deuterium Tungsten Light Source** is optimized for the UV. It produces continuous spectral output from ~200-850 nm.
- The **D-1000 Deuterium Light Source** is a high-output, fiber optic light source optimized for the UV. It produces intense, continuous spectral output from ~200-400 nm.
- The **DT-1000 Deuterium Tungsten Halogen Light Source** combines a UV and VIS/NIR light source in a single optical path. It's range is from ~200-1100 nm.

LS-1

- The **LS-1 Tungsten Halogen Light Source** is a versatile white light source for the VIS-Shortwave NIR (360 nm-2 µm). It offers high color temperature, a long life and a built-in filter slot for color-correcting and other uses.Users can easily replace old bulbs with new ones.
- The **PX-2 Pulsed Xenon Lamp** (~225-700 nm) is a 220 Hz short-arc flashlamp for UV-VIS applications. It produces high-energy pulses of brief duration and has two trigger modes.
- The **LS-450 Blue LED Pulsed Light Source** is a compact, low-cost light-emitting diode that produces pulsed or continuous spectral output at 470 nm to provide excitation for fluorescence measurements.

HG-1

LS-1-CAL

- The **LS-1-CAL Calibrated Light Source** is a NIST-traceable calibrated light source for the VIS-Shortwave NIR specifically calibrated for optical fibers. The calibration data includes absolute intensities at the fiber entrance port between 300-1050 nm.
- The **HG-1 Mercury Argon Calibration Source** produces Mercury and Argon emission lines from 253-922 nm for performing fast, reliable spectrometer wavelength calibrations.

MINI-D2T Miniature Deuterium Tungsten Light Source

The **MINI-D2T Miniature Deuterium Tungsten Light Source** combines the continuous spectrum of an RF-coupled deuterium UV light source and a tungsten halogen VIS/Shortwave NIR light source in a single optical path. The combined-spectrum light source produces a peak-to-peak stability of 0.3% from ~200-850 nm.

Parts Included

- MINI-D2T Miniature Deuterium Tungsten Light Source
- Power cord for connecting the MINI-D2T to outlet
- 15-pin accessory cable for software control of the MINI-D2T

Caution!

- The beam emerging from the MINI-D2T produces ultraviolet radiation. Direct eye contact could cause eye injury. Safety eyewear is recommended.
- Never look directly into the light source or stare at the diffuse reflected beam.
- Dangerous voltages present. NO serviceable parts inside unit. To replace bulbs, contact Ocean Optics.
- This instrument should not be used for any clinical or diagnostic purposes.
- Handle with care. Dropping the instrument may cause permanent damage.

Operation

Setting Up the MINI-D2T

1. Attach an optical fiber (the illumination fiber) to the SMA connector on the front of the MINI-D2T and attach the other end of this fiber to the SMA connector on your sampling chamber. Connect the second optical fiber (the read fiber) from the sampling chamber to the spectrometer. If you have a direct-attach cuvette holder on the MINI-D2T, simply attach an optical fiber from the cuvette holder to the spectrometer.
2. Plug the wall transformer into a standard 110 V outlet. Plug the 12 V output into the back of your MINI-D2T above the 12V label. For users of European-version wall transformers, plug the transformer into a standard 220 V outlet. At this time, the green LED indicator light on the front of the lamp will be lit. This indicator light only means that the lamp is receiving power, not that the deuterium and tungsten bulbs are on.

Operating the MINI-D2T Manually

1. Find the switch on the back of the MINI-D2T.
2. There are three positions: On, Off, and Remote. For Manual operation, move the switch to the On position. There can be up to a 1.5 second delay between switching the lamp to on and the bulbs igniting. If the lamp has not been used recently, the deuterium bulb may take up to 60 seconds to ignite.
3. For 0.3% peak-to-peak stability, allow 30 minutes warm-up time before taking your measurements.

Operating the MINI-D2T through Software

1. Take the 15-pin accessory cable and plug one end into the spectrometer. Connect the other end of the accessory cable into the back of the MINI-D2T.
2. Find the switch on the back of the MINI-D2T. There are three positions: On, Off, and Remote. For Software operation, move the switch to the Remote position. Moving the switch to the Remote position enables you to control the lamp through the software, whether the software you are using is OOIChem or OOIBase32.
3. When using OOIChem, select **Spectrometer | Enable Strobe** from the menu to turn the MINI-D2T on and off.

4. When you want to control the MINI-D2T through OOIBase32 Spectrometer Operating Software, select or deselect the **Strobe Enable** box in the Acquisition Parameter dialog bar above the graph area to turn the light source in the MINI-D2T on and off.
5. There can be up to a 1.5 second delay between turning the bulbs on via the software and the bulbs igniting. If the lamp has not been used recently, the deuterium bulb could take up to 60 seconds to ignite.
6. For 0.3% peak-to-peak stability, allow 30 minutes warm-up time before taking your measurements.

Disabling the Tungsten or Deuterium Bulb

It is possible to disable the deuterium or the tungsten bulb in the MINI-D2T. Both bulbs are enabled at the time of manufacture. In order to disable the deuterium or tungsten bulb, you must remove the casing of the MINI-D2T.

Disabling the Deuterium Bulb

It is possible to enable or disable the deuterium lamp. Jumper block JA of the MINI-D2T's circuit board controls the deuterium bulb. Short pins 2-3 (that is, place a jumper over pins 2-3 of JA) to enable the deuterium bulb. Short the pins 1-2 (that is, place a jumper over pins 1-2 of JA) to disable the deuterium bulb.

Disabling the Tungsten Bulb

It is possible to enable or disable the tungsten lamp as well. Jumper block JB of the MINI-D2T's circuit board controls the tungsten bulb. Short pins 2-3 (that is, place a jumper over pins 2-3 of JB) to enable the tungsten bulb. Short pins 1-2 (that is, place a jumper over pins 1-2 of JB) to disable the tungsten bulb.

Using Solarization-resistant Fibers

Our 300-µm Diameter Solarization-resistant Optical Fiber consists of a silica core, surrounded by a silica cladding material. The fiber is then coated in aluminum. Our solarization-resistant fibers are best used for regions below 250 nm, or for applications where exposure to long-term UV light occurs. Solarization is the loss of transparency in glass due to exposure to ultraviolet radiation. If you are using a UV light source, the UV radiation degrades the silica in a standard patch cord fiber over time, resulting in increased overall absorption values and invalid data.

Replacing the Bulbs

The deuterium and tungsten bulbs cannot be replaced by unauthorized personal. To replace a bulb in the MINI-D2T, contact Ocean Optics.

Specifications

Deuterium wavelength range:	200-400 nm
Tungsten wavelength range:	360-850 nm
Deuterium bulb life:	800 hours
Tungsten bulb life:	2,000 hours
Ignition delay:	~1.5 seconds to 60 seconds
Peak-to-peak stability:	0.3% in 30 minutes 1.0% in 10 minutes
Connector:	SMA 905
Power input:	12 V
Power requirement:	12 VDC/420 mA
Power consumption:	5 watts (deuterium 3.8 watts, tungsten 1.2 watts)

D-1000 Deuterium Light Source

The **D-1000 Deuterium Light Source** is a high-output, high stability fiber optic light source optimized for the UV. The D-1000 produces intense, continuous spectral output from ~200-400 nm, making it especially useful for UV spectroscopy. The D-1000 has a highly stabilized microprocessor-based power supply designed for optimum stability, with a maximum fluctuation of just 0.05% peak-to-peak and drift of +/- 0.5%/hr. The lamp can be controlled from the switches on the front panel or through digital lines.

Parts Included

- D-1000 Deuterium Light Source
- Safety eyewear for protection against dangerous ultraviolet radiation
- Power cord for connecting D-1000 to outlet
- Allen wrench for adjusting the focus of the collimating lens

Caution!

- The beam emerging from the D-1000 produces visible light and invisible ultraviolet radiation. Direct contact with the beam could cause serious eye injury. Safety eyewear must be worn at all times while operating the D-1000. Do not remove any safety device installed.
- Dangerous voltages present. Only qualified service personnel should service the D-1000.
- This instrument should not be used for any clinical or diagnostic purposes.
- Handle with care. Dropping the D-1000 may cause permanent damage.
- For optimum performance below 250 nm, use a solarization-resistant fiber with this lamp.

Operation

Allow 30 minutes for the lamp to warm up and for the power to stabilize. The spectral output as delivered by an optical fiber will decrease significantly at wavelengths lower than 250 nm due to attenuation in the lamp envelope, the decrease in detector efficiency in the spectrometer, and attenuation by the fiber.

1. Put on safety eyewear.
2. Lift the black protective shutter covering the fiber optic port. Remove the red plastic cap that covers the SMA connector and install an optical fiber. (For best results, use our solarization-resistant fibers.)
3. Plug the power cord into the rear of the D-1000. Plug the other end into a 110 VAC outlet.
4. Locate the black power switch at the rear of the D-1000, just above where the power cord connects to the D-1000. Turn on the power. When the power is on, the green **Power On** light located at the bottom right of the front panel will light.
5. Push in the **UV Start** button located on the front panel. This white button turns on the deuterium lamp. Pushing in the **UV Start** button initiates the start up sequence for the lamp. First, the heater in the deuterium lamp ionizes the available deuterium. At this point, the yellow **Heater On** light on the front panel will light. Next, after ~30 seconds, the red **UV On** light located at the top of the front panel will light. (The **Heater On** light will turn off at the same time.) Once the red **UV On** light is lit, the deuterium lamp is ready for your application. Best results are obtained after the lamp has warmed up for 30 minutes.
6. Without a solarization-resistant fiber, the spectral output will decrease significantly as a function of time at wavelengths lower than 250 nm.
7. To turn off the deuterium lamp, first press the white **UV Off** button located on the front panel. Then, flip the power switch at the rear of the D-1000, just above where the power cord connects to the D-1000. The green **Power On** light on the front panel will go out.

8. Lift up the black protective shutter and disconnect your optical fiber from the SMA connector.
9. Replace the red plastic cap over the SMA connector.

Bulb Replacement

1. Order a replacement bulb, item D-1000-B, from Ocean Optics.
2. Make sure the D-1000 is turned off, the power cord is disconnected and the lamp has cooled.
3. Use a Phillips-head screwdriver to remove all 12 screws from the side panels of the D-1000 casing. **Do not** remove *any* screws from the front, back, or bottom panels. Remove the cover.
4. Find the deuterium bulb. It is located at the front of the housing, mounted on a black platform. Three wires lead from the bottom of the bulb to the electronic board: one red wire (with a time indicator) and two black wires.
5. Use a Phillips-head screwdriver to loosen the screws securing these three wires to the green electronic board. Once the screws are loose, gently remove the red wire and the two black wires. You do not need to completely remove the screws to detach the wires. (Note that on the green electronic board, just right of each wire, is a letter. To the right of the red wire is the letter “A”. To the right of one black wire is the letter “H” and to the right of the second black wire is the letter “C”.)
6. In order to remove the bulb, you will need to unscrew the nut holding the collimating lens and SMA connector in place. It is positioned in such a way that if the nut remains in place, you will not be able to take out the deuterium bulb. Use a 3/8” wrench to remove the nut.
7. Use a Phillips-head screwdriver to remove the two screws securing the bulb to the black platform.
8. Remove the old bulb unit. Inspect the new bulb unit, but **avoid touching the glass casing** (or envelope) around the bulb as the oils from your skin will deteriorate the bulb. Inside the envelope is a triangle-shaped filament. The filament has a **square** opening. The light passes through the square opening to the collimating lens. Take the new bulb, carefully feeding the three wires through the hole in the black platform, and position it so that the square opening in the filament faces the collimating lens.
10. Screw in the two screws that holds the bulb to the platform and the nut that holds the collimating lens in place.
12. Secure the three wires to the green electronic board. Attach the red wire to the top screw, labeled “A”. Attach the black wires to the screws on the board labeled “H” and “C”. **It does not matter which black wire is attached to screw “H” or “C”**.
13. Put the D-1000 cover back on and secure it with the 12 screws.

For directions on adjusting the focus of the collimating lens on the D-1000, turn to **Appendix B**.

Specifications

Spectral range:	~200-400 nm
Time to stabilized output:	~30 minutes
Power consumption:	25-30 Watts
Bulb lifetime:	1,000 hours (replacement bulbs available)
Stability:	peak-to-peak = 0.05% (maximum); drift of +/-0.5%/hour
Aperture:	0.5 mm (at lamp)
Connector:	SMA 905
Window material:	0.4 mm thickness UV-transmissive glass
Lamp voltage:	85 volts DC (nominal)
Operating lamp current:	300 mA DC (+/- 1mA)
Timing:	microprocessor-based
Inputs:	trigger inputs for lamp (on/off)
Outputs:	levels for lamp (on/off), filament (on/off)
Power requirements:	120 volts AC @ 0.50 A, 50-60 Hz 220 volts AC @ 0.25 A, 50-60 Hz 100 volts AC @ 0.60 A, 50-60 Hz 240 volts AC @ 0.20 A, 50-60 Hz

DT-1000 Deuterium Tungsten Halogen Light Source

The **DT-1000 Deuterium Tungsten Halogen Light Source** combines the continuous spectrum of a deuterium UV light source and a tungsten-halogen VIS/Shortwave NIR light source in a single optical path. The combined light source produces a powerful, stable output from ~200-1100 nm. It also has a highly stabilized microprocessor-based power supply designed for optimum stability.

Parts Included

- DT-1000 Deuterium Tungsten Halogen Light Source
- Safety eyewear for protection against dangerous ultraviolet radiation
- Power cord for connecting DT-1000 to outlet
- Allen wrench for adjusting the focus of the collimating lens

Caution!

- The beam emerging from the DT-1000 produces visible light and/or invisible ultraviolet radiation. Direct contact with the beam could cause serious eye injury.
- Safety eyewear must be worn at all times while operating the DT-1000. Do not remove any safety device installed.
- Dangerous voltages present.
- Only qualified service personnel should service the DT-1000.
- This instrument should not be used for any clinical or diagnostic purposes.
- Handle with care. Dropping the instrument may cause permanent damage.
- For optimum performance below 250 nm, use a solarization-resistant fiber with this lamp.

Operation

Allow several minutes for the lamp to warm up and for the power to stabilize, regardless of the bulb being used. Best results are obtained after 30 minutes. The spectral output as delivered by an optical fiber will decrease significantly at wavelengths lower than 250 nm due to attenuation in the lamp envelope, the decrease in detector efficiency in the spectrometer, and attenuation by the fiber.

1. Put on safety eyewear.
2. Lift the black protective shutter covering the fiber optic port. Install an optical fiber. (For best results, use our solarization-resistant fibers.)
3. Plug the power cord into the rear of the DT-1000. Plug the other end into a 110 VAC outlet.
4. To turn on the power for the DT-1000, flip the power switch at the rear of the unit, just above where the power cord connects to the DT-1000. When the power is on, the green **Power On** light located at the bottom right of the front panel will light. At this time, the user can now power up the deuterium or tungsten-halogen source or both. (See the following **Operating the Deuterium Source** and **Operating the Tungsten-Halogen Source** sections for more information.)
5. To turn off the DT-1000, both deuterium and tungsten-halogen sources must be turned off first. Only then can the user flip the power switch at the rear of the unit to the off position. The green **Power On** light will turn off.
6. Lift up the black protective shutter and disconnect your optical fiber from the SMA connector.

Operating the Deuterium Source

1. To power the deuterium lamp, push in the **UV Start** button located on the front panel. This white button turns on the deuterium lamp. Pushing in the **UV Start** button initiates the start-up sequence for the lamp. First, the heater in the deuterium lamp ionizes the available deuterium. At this point, the yellow **Heater On** light on the front panel will light. After ~30 seconds, the red **UV On** light located at the top of the front panel will light. (The **Heater On** light will turn off at the same time.)
2. To turn off the deuterium lamp, press the white **UV Off** button located on the front panel. The red **UV On** light should go out.

Operating the Tungsten-Halogen Source

1. To power the tungsten-halogen lamp, push in the white button **Visible On**. The red **Vis. On** light will come on.
2. To turn off the tungsten-halogen lamp, press the white **Visible On** button located on the front panel. The red **Vis. On** light will go out.

Bulb Replacement

Replacing the Deuterium Bulb

1. Order a deuterium replacement bulb, item DT-1000-BD, from Ocean Optics.
2. Make sure the DT-1000 is turned off, the power cord is disconnected, and the source has cooled.
3. Use a Phillips-head screwdriver to remove all 12 screws from the side panels of the DT-1000 casing. **Do not** remove *any* screws from the front, back, or bottom panels. Remove the cover.
4. Locate the deuterium bulb. It is located at the front of the housing, mounted on a black platform. Three wires lead from the bottom of the bulb to the green electronic board: one red wire and two black wires.
5. Use a Phillips-head screwdriver to loosen the screws securing these three wires to the green electronic board. Once the screws are loose, gently remove the red wire and the two black wires. You do not need to completely remove the screws to detach the wires. (Note that on the green electronic board, just to the right of each wire, is a letter. To the right of the red wire is the letter “A”. To the right of one black wire is the letter “H” and to the right of the second black wire is the letter “C”.)
6. Use a Phillips-head screwdriver to remove the two screws securing the bulb to the black platform.
7. Remove the old bulb unit.
8. Inspect the new bulb unit, but **avoid touching the glass casing** (or envelope) around the bulb, as the oils from your skin will deteriorate the bulb. Inside the envelope is a triangle-shaped filament. The filament has a **square** opening. The light passes through the square opening to the collimating lens. Take the new bulb, carefully feeding the three wires through the hole in the black platform, and position it so that the square opening in the filament faces the collimating lens.
9. Screw in the two screws that secure the bulb to the black platform.
10. Secure the three wires to the green electronic board. Attach the red wire to the top screw, labeled “A”. Attach the black wires to the screws on the board labeled “H” and “C”. **It does not matter which black wire is attached to screw “H” or “C”**.
11. Put the DT-1000 casing back on and secure it with the 12 screws.

Replacing the Tungsten-Halogen Bulb

1. Order a tungsten-halogen replacement bulb, item DT-1000-BT, from Ocean Optics.
2. Remove all 12 screws from the side panels of the DT-1000 casing using a Phillips-head screwdriver. **Do not** remove *any* screws from the front, back, or bottom panels. Remove the cover.
3. Locate the tungsten-halogen bulb. It is inserted on the top of a cylindrical unit held by a set screw in a hole in the black platform. The cylindrical unit is positioned behind the deuterium bulb. Two thin wires lead from the bottom of the unit to a socket on the electronic board.

4. Gently grip the top of the bulb and pull it away from the cylindrical unit. Discard the bulb.
5. Insert the new bulb into the top of the cylinder, being careful to position the bulb's pins over the holes in the top of the cylinder.

The cylindrical unit is held in place with a small set screw. By loosening it, the user can slide the bulb unit up and down, positioning it in front of the attenuator, a metal disc that attenuates the light before going through the collimating lens. Another set screw holds the attenuator in place.

6. Put the DT-1000 casing back on and secure it with the 12 screws.

For directions on adjusting the focus of the collimating lens on the DT-1000, turn to **Appendix B**.

Specifications

Spectral range:	~200-1100 nm
Time to stabilized output:	~30 minutes
Deuterium bulb lifetime:	1,000 hours
Tungsten-halogen bulb lifetime:	900 hours
Power consumption:	25-30 Watts
Stability:	peak-to-peak = 0.05% (maximum) drift of +/-0.5%/hour
Aperture:	0.5 mm (at lamp)
Connector:	SMA 905
Lamp voltage:	85 volts DC (nominal)
Operating lamp current:	300 mA DC (+/- 1mA)
Inputs:	trigger inputs for lamp (on/off)
Outputs:	levels for lamp (on/off), filament (on/off)
Power requirements:	120 volts AC @ 0.50 A, 50-60 Hz 220 volts AC @ 0.25 A, 50-60 Hz 100 volts AC @ 0.60 A, 50-60 Hz 240 volts AC @ 0.20 A, 50-60 Hz

LS-1 Tungsten Halogen Light Source

The **LS-1 Tungsten Halogen Light Source** is a versatile, white-light lamp utilized for the VIS-Shortwave NIR (360 nm-2 µm). The lamp, available with either a 900-hour or 10,000-hour bulb, offers high color temperature and extremely efficient output.

Parts Included

- LS-1 Tungsten Halogen Light Source
- 12 VAC power supply
- Allen wrench for adjusting the collimating lens

Caution!

- DO NOT insert plastic or flammable materials into the filter slot. The materials could melt or ignite. The unit could ignite flammable materials that come in contact with the metal housing.
- The LS-1 becomes **HOT** during operation. No cooling fan is installed in the LS-1. Handle with care.

Operation

Turning On the Lamp

1. Plug the wall transformer end into a standard 110 V outlet. Plug the 12 V output end into the back of the LS-1.
2. Screw a fiber into the SMA connector on your LS-1.
3. Find the on/off switch on the back of the lamp and turn the lamp on. Allow the lamp to warm up for approximately 30 minutes.

Using the Filter Slot

The slot between the lamp and the fiber coupler can be used to hold filters or light blocks. You can place a filter into the filter slot; however, be aware of the following:

- The filter slot accepts filters up to 3 mm thick.
- Because the lamp can become hot, avoid plastic filters as they may melt.
- The unit could ignite flammable materials that come in contact with the metal housing.
- There is no filter clamping screw for holding filters in place.

The most useful filters include the following:

- an FG-3 blue filter for increasing the relative energy near 400 nm and 800 nm compared to 600 nm
- an IR cutoff filter to reduce stray light below 750 nm
- a 550 nm long pass filter to eliminate second-order effects on Shortwave NIR measurements

Replacing the Bulb

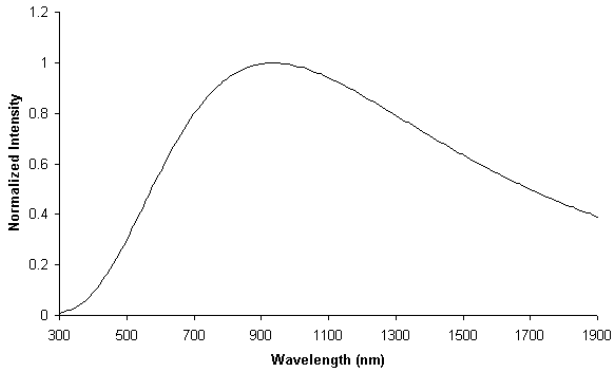
1. Order a replacement bulb (LS-1-B for a 900-hour bulb or LS-1-LL-B for a 10,000-hour bulb).
2. Turn off the LS-1 and allow the lamp to cool.
3. Use an Allen wrench to loosen the set screw on the bottom of the lamp. You do not need to remove the set screw. This screw holds the bulb in place.

4. Locate the two set screws at the back of the lamp, one above each back leg. These two screws keep the two halves of the lamp together. Remove the two screws.
5. Gently separate the two halves of the lamp.
6. Carefully pull the bulb out of its housing. Detach the wire and lamp leads from the socket. Remove the old bulb unit and discard.
7. Plug the new bulb into the socket.
8. Slide the new bulb forward into the front of the lamp as far as it will go.
9. Gently tighten the set screw on the bottom of the lamp.
10. Close together the two halves of the lamp, being careful not to pinch the wires.
11. Replace the two screws at the back of the lamp.

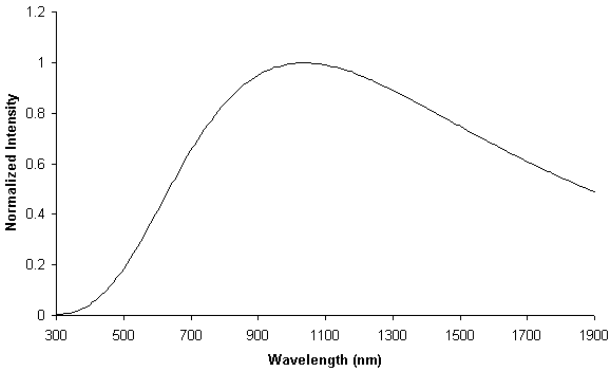
For directions on adjusting the focus of the collimating lens on the LS-1, turn to **Appendix B**.

Spectral Output

These graphs represent normalized blackbody curves for tungsten halogen light sources with 2800K and 3100K color temperatures. The observed spectral output of the LS-1 will vary due to bulb type, the spectrometer configuration, the sampling optics used, and inherent fluctuations in LS-1 output.



900-hour bulb / 3100K



10,000-hour bulb / 2800K

Specifications

Spectral range:	360 nm - 2 microns*
Dimensions:	9.0 cm x 5.0 cm x 3.2 cm (LWH), 3.5" x 2.0" x 1.25" (LWH)
Power input:	12 VDC/800 mA, 7-20 VDC/0.5-2 amps
Power output:	6.5 watts
Bulb life:	900 hours (standard), 10,000 hours (long-life)
Bulb color temperature:	900-hour bulb = 3100K, 10,000-hour bulb = 2800K
Output to bulb:	5 volts/1.3 amps
Output regulation:	0.2% voltage
Time to stabilized output:	~30 minutes
Bulb output:	7400 foot-candles (7.4MSCP)
Connector:	SMA 905

* Though the product can be used to 2 µm, it can be configured to "see" only to 1100 nm with our USB2000 spectrometer.

PX-2 Pulsed Xenon Lamp

The **PX-2 Pulsed Xenon Lamp** is a high flash rate, short-arc xenon lamp for applications involving absorbance, reflection, fluorescence and phosphorescence measurements. The PX-2 operates at speeds up to 220 Hz and offers critical pulse-to-pulse stability.

Parts Included

- PX-2 Pulsed Xenon Lamp
- 15-pin cable for connecting the PX-2 to the spectrometer
- 12V DC wall transformer for supplying power to the PX-2

Caution!

- The beam emerging from the PX-2 produces ultraviolet radiation. Direct contact with the beam could cause eye injury. Never look directly into the light source.
- Dangerous voltages present. Never operate the PX-2 without its housing intact.
- The SMA connector may get **HOT** during operation.
- This instrument should not be used for any clinical or diagnostic purposes.
- Handle with care. Dropping the instrument may cause permanent damage.

Operation

The lamp is triggered with TTL pulses delivered through the 15-pin connector located at the rear of the unit. Our USB2000-series spectrometers and software, or any source of TTL signals, supplies these pulses. The lamp is powered by a 12V DC transformer, or from a 12V battery if field use is desired.

1. Plug the wall transformer into a 110V outlet. Plug the other end of the cord into the jack at the rear of the PX-2.
2. Install the 15-pin cable into the rear of the PX-2. Connect the other end to the 15-pin connector on an USB2000.
3. Connect an optical fiber to the SMA-terminated fiber optic port on the front panel.
4. Turn the power switch located at the rear of the source to the “ON” position.
5. Select either “MULTIPLE” or “SINGLE” flash mode by moving the toggle on the rear of the source.
6. Configure OOIBase32 operating software to operate the PX-2. In the **Acquisition Parameters** dialog bar, check the **Strobe Enable** box. You can also enable this function by selecting **Spectrum | Configure Data Acquisition** from the menu and then choosing the **Strobe** page of the dialog box.
7. The flash should fire with a clearly audible “ping.”

Application Tips

Single Flash Mode

Using the Single flash mode results in one flash per integration cycle. Since the PX-2 has a maximum repetition rate of 220 Hz, the minimum integration allowed in this mode is 5 milliseconds.

Multiple Flash Mode

When using the Multiple flash mode the user needs to ensure that a constant number of flashes occurs for every integration cycle by setting the pulse rate and integration time. This achieves a continuous and stable signal. The pulse rate is determined by the USB2000. The integration time is controlled via the operating software.

Specifications

Spectral range:	220-750 nm
Approximate dimensions:	14 cm x 10.5 cm x 4 cm (LWH) 5.5" x 4.1" x 1.5" (LWH)
Power input:	1.3 A @ 11V @ 220 Hz 100 mA @ 12V @ 10Hz
Trigger input:	external TTL positive pulse via 15-pin connector
Output:	45 millijoules per pulse maximum 9.9 watts average power 220 Hz pulse rate maximum
Pulse duration:	5 microseconds (at 1/3 height of pulse)
Lifetime:	10^9 pulses (estimated 230 days continuous operation at 50 Hz pulse rate)
Aperture:	3 mm
Connector:	SMA 905
Timing signals available from S2000 spectrometers:	Multiple mode = up to 220 Hz (varies with A/D sampling frequency) Single mode = varies with scan rate

LS-450 Blue LED Pulsed Light Source

The **LS-450 Blue LED Pulsed Light Source** is a compact, low-cost light-emitting diode that produces pulsed or continuous spectral output at 470 nm -- the blue region -- for high-sensitivity emission fluorescence measurements. The LS-450 excitation source can be combined with other sampling optics for fluorescence applications.

Operation

1. Plug the wall transformer into a standard 110V outlet and into the back of the LS-450.
2. Screw an optical fiber onto the SMA connector on the front of the light source.

Using the Continuous Mode

1. Turn the switch on the back of the LS-450 to “contin.” The continuous mode simply means that the light coming from the LS-450 is continuous.
2. To turn the lamp off, simply change the position of the switch to "off."

Using the Pulsed Mode

1. Plug one end of the DB-15 accessory connector into the back of the LS-450 and the other end into the back of the USB2000.
2. Turn the switch on the back of the LS-450 to “pulsed.” for pulsed mode of operation.
3. The pulsing of the LS-450 is controlled through the spectrometer.
4. When using the pulsed flash mode, the user needs to ensure that a constant number of flashes occurs for every integration cycle. In OOIBase32, set the integration time in the acquisition dialog bar above the graph area (See the **OOIBase32 Operating Software Manual** for more information about the integration time.)

HG-1 Mercury Argon Calibration Source

The **HG-1 Mercury Argon Calibration Source** is a wavelength calibration source for UV-VIS-Shortwave NIR spectrophotometric systems. The HG-1 produces Mercury and Argon lines from 253-922 nm, for use in performing fast, accurate spectrometer wavelength calibrations. The HG-1 has an SMA 905 termination for connecting to optical fibers.

Caution!

- The beam emerging from the HG-1 produces ultraviolet radiation. Direct contact with the beam could cause serious eye injury. Never look directly into the light source.
- *Never* take apart the HG-1. The HG-1 contains mercury. Dangerous voltages present. No user-serviceable parts inside.
- The SMA connector may get **HOT** during operation.

Setting Up

To re-calibrate the wavelength of your spectrometer, you will need the following:

- The HG-1 Mercury-Argon lamp
- Your spectrometer
- An optical fiber (for spectrometers without a built-in slit, a 50-µm fiber works best)
- Either a spreadsheet program (Excel or Quattro Pro, for example) or a calculator that performs third-order linear regressions. If you are using Microsoft Excel, choose **Tools | Add-Ins** and check **AnalysisToolPak** and **AnalysisToolPak-VBA**

Operation

1. Plug the wall transformer end of the HG-1's power supply into a standard 110 V outlet. Plug the 12 V output end into the back of your HG-1. Or, insert a 9V battery (not included).
2. Attach a fiber from the spectrometer into the SMA connector on your HG-1. If your spectrometer does not have an entrance slit, use a 50-µm diameter (or smaller) optical fiber. Larger fibers and slits will have lesser optical resolution. Also, keep in mind that if the spectrometer has no slit and your experimentation involves using optical fibers of different diameters, wavelength calibration with each fiber you anticipate using will be necessary. Calibration is also recommended each time you unscrew the fiber from the spectrometer.
3. Find the on/off switch next to the SMA connector and turn the lamp on. The red indicator will light when the lamp is on.

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:

$$\lambda_p = I + C_1 p + C_2 p^2 + C_2 p^3$$

where λ is the wavelength of pixel p, I is the wavelength of pixel 0, C_1 is the first coefficient (nm/pixel), C_2 is the second coefficient (nm/pixel^2), and C_3 is the third coefficient (nm/pixel^3). You will be calculating the value for I and the three Cs.

1. After placing OOIBase32 into Scope Mode, take a spectrum of your light source. Adjust the integration time until there are several peaks on the screen that are not off-scale.
2. Move the cursor to one of the peaks and carefully position it so that it is at the point of maximum intensity. Record the pixel number that is displayed in the status bar (located beneath the graph). Repeat this step for all of the peaks in your spectrum.
3. Using your spreadsheet, create a table like the one below. In the first column, place the exact or true wavelength of the spectral lines that you used. The spectral lines of the HG-1 are printed on the lamp's casing. 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 → True Wavelength (nm)

Dependent Variables → Pixel #, Pixel # ^{2}, Pixel # ^{3}

Values computed from the regression output → Predicted Wavelength, Difference

True Wavelength (nm)	Pixel #	Pixel # ^{2}	Pixel # ^{3}	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

4. Now you are ready to calculate the wavelength calibration coefficients. In your spreadsheet program, find the functions to perform linear regressions. If you are using Quattro Pro, look under **Tools | Advanced Math**. If you are using Excel, look under **Tools | Data Analysis**.
5. 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 you execute the regression, an output similar to the one shown below is obtained.

Regression Statistics	
Multiple R	0.999999831
R Square	0.999999663
Adjusted R Square	0.999999607
Standard Error	0.125540214
Observations	22

intercept

	Coefficents	**Standard Error**
Intercept	190.473993	0.369047536
X Variable 1	0.36263983	0.001684745
X Variable 2	-1.174416E-05	8.35279E-07
X Variable 3	-2.523787E-09	2.656608E-10

first coefficient

second coefficient

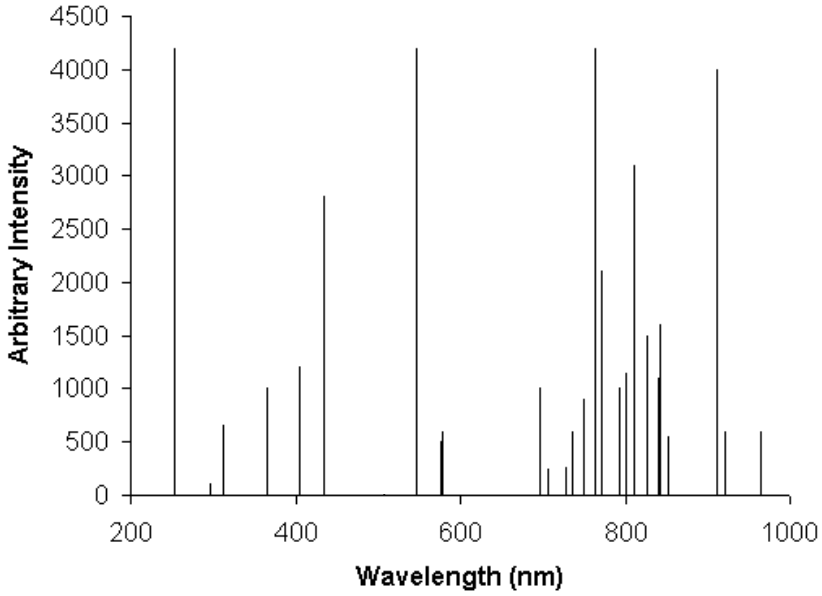
third coefficient

6. The numbers of importance are indicated in the above figure. You will need to record the Intercept as well as the First, Second, and Third Coefficients. Also, look at the value for R squared. It should be *very* close to 1. If it is not, you have probably assigned one of your wavelengths incorrectly.
7. Select **Spectrometer | Configure** from the menu and choose the **Wavelength Calibration** page to update the wavelength coefficients within OOIBase32.
8. Repeat this process for each channel in your setup.

Spectral Output

Mercury emission lines are <600 nm. Argon emission lines are >600 nm, and are shown here on the right on an exaggerated amplitude scale. Below is a list of the most prominent mercury and argon peaks.

Mercury Lines	Argon Lines
253.65	696.54
296.73	706.72
302.15	710.75
313.16	727.29
334.15	738.40
365.01	750.39
404.66	763.51
407.78	772.40
435.84	794.82
546.08	800.62
576.96	811.53
579.07	826.45
	842.46
	852.14
	866.79
	912.30
	922.45



Specifications

Output:	low-pressure gas discharge lines of Mercury and Argon
Spectral range:	253-922 nm
Dimensions:	11.4 cm x 6.98 cm x 2.54 cm (LWH), 4.5" x 6.98" x 1.0" (LWH)
Power requirements:	12 VDC wall transformer (comes with unit) **or** 9 VDC battery
Internal voltage:	600 volts at 30 kHz
Bulb life:	~3,500 hours
Amplitude stabilization:	~1 minute
Aperture:	3 mm
Connector:	SMA 905

LS-1-CAL Calibrated Light Source

The **LS-1-CAL Calibrated Light Source** for the VIS-Shortwave NIR (300-1050 nm) is a tungsten halogen light source that provides you with known absolute intensity values at several wavelengths, expressed in µW/cm²/nm. Since the spectral intensity of the LS-1-CAL can be traced to an intensity standard provided by the National Institute of Standards and Technology (NIST), it is specifically designed for calibrating the absolute spectral response of your system.

Parts Included

- LS-1-CAL Calibrated Light Source
- Switching AC adapter for stabilizing power
- Power cord for supplying power to the power supply
- Two Lamp Calibration Reports; one for using the LS-1-CAL with a bare fiber and one for using the LS-1-CAL with a CC-3 cosine-corrected irradiance probe
- A disk that holds files for both lamp calibration reports
- Allen wrench for adjusting the inner barrel of the SMA connector

Caution!

- The LS-1-CAL becomes **HOT** during operation. DO NOT insert flammable materials into the filter slot. The materials could melt or ignite.Handle with care.
- The LS-1-CAL is not designed as an illumination source for absorbance, transmission or reflection measurements. The LS-1 Tungsten Halogen Light Source should be used for those applications.

Setting Up

The LS-1-CAL is designed to calibrate the absolute spectral response of your system. Before beginning, make sure you have your LS-1-CAL, your spectrometer, an SMA-terminated optical fiber or CC-3 cosine-corrected irradiance probe, and OOIIrrad Ocean Optics Irradiance Software. (If you have a spectrometer setup that is highly sensitive, you may not be able to use the LS-1-CAL as a calibration source.)

Using the LS-1-CAL for Calibration

1. Use an Allen wrench to loosen the set screw on the LS-1-CAL's SMA connector.
2. If you are using a bare fiber with the lamp, withdraw the inner barrel from the SMA connector. Screw this connector barrel onto the end of your fiber. The connection should be tight. Insert the barrel/fiber all the way into the LS-1-CAL's SMA connector. If you are using a fiber and cosine corrector with the lamp, remove the inner barrel from the SMA connector. Screw the CC-3 cosine corrector onto the end of the fiber. The connection should be tight. Insert the CC-3/fiber all the way into the LS-1-CAL's SMA connector, taking the place of the SMA's inner barrel.
3. Use an Allen wrench to tighten the set screw on the SMA connector of the LS-1-CAL. Take the other end of the fiber and screw it all the way into the SMA connector of the spectrometer.
4. Plug the switching AC adapter (the black rectangle-shaped box) into the back of the LS-1-CAL. The adapter stabilizes the power coming into the lamp to insure constant spectral intensity.
5. Plug the power cord into a standard outlet. Plug the other end of the power cord into the back of the switching AC adapter.

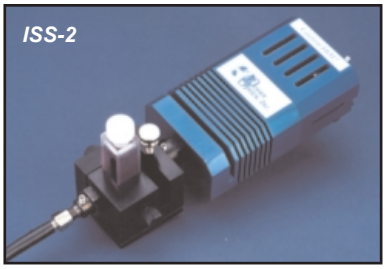
6. Find the on/off switch on the back of the lamp and turn the lamp on.
7. Let the lamp warm up for at least 15 minutes before using.
8. Insert the disk that came with your lamp into your computer. The disk contains two ASCII files. These files have the same information as the Lamp Calibration Reports that came with your LS-1-CAL. One file has the calibration numbers for calibrating the spectral response of your system with the lamp and a *bare fiber*; its name contains the lamp's serial number, followed by **FIB.LMP**. The second file has the calibration numbers when calibrating the spectral response of your system with the lamp and a *CC-3 cosine-corrector and fiber*; its name contains the lamp's serial number, followed by **CC3.LMP**.
9. Copy these two files into your OOIIrrad Irradiance Software directory.
10. Start OOIIrrad Irradiance Software. Make sure you are in **Scope Mode**.
11. Under the **Lamp** menu options, choose **Select Lamp**. A window opens in which you must choose the Lamp Calibration Report file that reflects your optical setup.
12. Under the **Spectrometer** menu options, choose **Configure Fibers**. Enter the fiber diameter values for each channel in your setup. If using a bare fiber, enter the fiber's diameter here. If using a fiber with a CC-3 cosine corrector, enter 3,900. Whatever optical setup you wish to use for your application, you must also use for calibrating the spectral response of your system. For example, if you are going to use a 200-µm fiber with a CC-3 cosine corrector for your application, you must use the same 200-µm fiber and CC-3 for calibrating the spectral response of your system.
13. To the right of the displayed spectrum, enter the data acquisition parameters for your setup. The values for Scans to Average and Smoothing Size must be the same for your reference, dark and irradiance scans. You may use a different integration period for your reference scan, but you must use the same integration period for your dark and irradiance scans.
14. Under **Spectrometer** menu options, choose **Calibrate** and then select the channel you are calibrating.
15. A dialog box opens with the message **Verify lamp was ON for at least 15 minutes for a REFERENCE scan.** Make sure nothing is blocking the light path going to your spectrometer. Your setup (spectrometer, fiber, and sampling optics) for taking a reference should be identical to your setup for measuring your sample. Taking a reference spectrum is requisite before the software can calculate absolute irradiance measurements. Click **OK**.
16. Another dialog box opens with the message **Block light path to spectrometer for a DARK scan.** If possible, do not turn off the light source. Instead, completely block the light path going to your spectrometer by inserting an opaque object into the lamp's filter slot. Taking a dark spectrum is requisite before the software can calculate absolute irradiance measurements. Click **OK**. The spectral response of your system is calibrated.
17. If you selected **Display calibration info when calculating** in the **Configure Spectrometer** dialog box, you will now see the results of the calibration procedure. The top left graph represents the linear 15th order polynomial regression. The top right graph represents the dark scan. The bottom graph is the calibration curve representing the spectral response of the process.
18. The calibration procedure is saved in a file named **CH0.CAL** for calibrating the master spectrometer channel, **CH1.CAL** for calibrating the first slave spectrometer channel, and so on.

Specifications

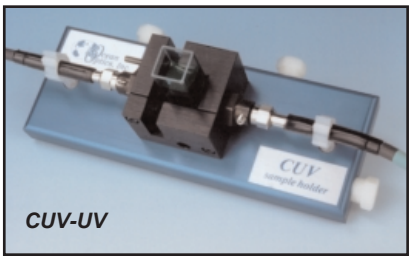
Spectral range (calibrated):	300-1050 nm
Dimensions:	9.0 cm x 5.0 cm x 3.2 cm (LWH); 3.5" x 2.0" x 1.25" (LWH)
Power input:	12 VDC/800 mA (regulated)
Power output:	6.5 watts
Bulb life:	900 hours (recalibrate after ~50 hours of use)
Bulb color temperature:	3100K
Output to bulb:	5 volts/1.3 amps
Output regulation:	0.2% voltage
Time to stabilized output:	~15 minutes
Connector:	SMA 905

Sampling Chambers

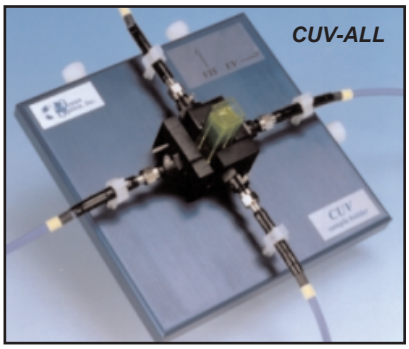
Ocean Optics offers a comprehensive line of compact, low-cost sampling chambers for a variety of UV-VIS-Shortwave NIR applications. Most sampling chambers have SMA terminations for easy coupling to optical fibers. Options include a variety of cuvette holders for 1-cm and 10-cm cuvettes, in-line filter holders, flow cells, and other sampling devices.


ISS-2

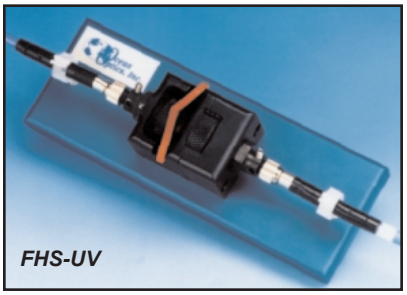
- **USB-ISS-VIS**, **ISS, ISS-2**, and **ISS-UV-VIS Integrated Sampling Systems** consist of compact light sources with integrated cuvette holders for 1-cm cuvettes. These versatile sampling devices couple to our spectrometers to create integrated, small-footprint sampling systems. The **USB-ISS-VIS** is a snap-on, direct-attach sampling system specifically for the USB2000.


CUV-UV

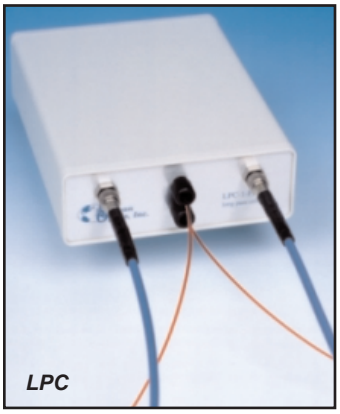
- **CUV-UV** and **CUV-VIS Cuvette Holders**, are our standard cuvette holders for 1-cm cuvettes. The **CUV-UV-10** and **CUV-VIS-10 Cuvette Holders** are cuvette holders for 10-cm paths. These sample holders come with a pair of 5-mm diameter f/2 collimating lenses, filter slots and SMA connectors.


CUV-ALL

- The **CUV-ALL 4-way Cuvette Holder** is a cuvette holder for 1-cm cuvettes that has fiber optic couplings at four collimators -- a pair of collimating lenses optimized for the UV-VIS and a pair optimized for the VIS-NIR. Also available is the **CUV-FL-DA Direct Attach Cuvette Holder**, a 1-cm cuvette holder that attaches directly to light sources. When combined with our spectrometers and light sources, the CUV-ALL and CUV-FL-DA can measure absorbance, fluorescence, scattering, or any combination of these optical phenomena.


FHS-UV

- The **USB-FHS**, **FHS-UV** and **FHS-VIS In-Line Filter Holders** provide a convenient platform for rapid absorbance or transmission measurements of optical and other filters. The **USB-FHS Filter Holder** is a snap-on, direct-attach filter holder made specifically for the USB2000.


LPC

- **LPC Long Pass Flow Cells** couple to our spectrometers and compact light sources to measure low-concentration aqueous samples. LPC Flow Cells are available in 1-meter, 5-meter and 10-meter path lengths for absorbance measurements, and in a 1-meter path length with built-in 365-nm excitation source for fluorescence measurements.

- The **CUV-CCE Electrophoresis Sample Cell** for chromatography and capillary electrophoresis is an optical fixture for measuring the absorbance of fluids in chromatography or capillary electrophoresis systems. The cell is attached on-line, i.e., the light is projected through the sides of fused silica tubing without violating the tube integrity.

USB-ISS-VIS Integrated Sampling System

The **USB-ISS-VIS Integrated Sampling System** snap-on, direct-attach 1-cm cuvette holder and visible light source combination was created specifically for the USB2000. When attached to the USB2000, it requires no power to operate; it receives its power from the computer to which the USB2000 is connected. The USB-ISS-VIS is preset for use with a 1-cm cuvette.

Operation

1. Remove power from the USB2000 by either disconnecting it from the PC to which it is interfacing or detaching the power cord.
2. Snap on the USB-ISS-VIS to the front of the USB2000 spectrometer.
3. When properly adjusted, the cuvette should fit snugly into the holder. Locate the ball plunger screw and use a screwdriver to loosen it until the end is visible in the holder.
4. Insert your cuvette into the holder.
5. Tighten the ball plunger screw until the ball contacts the cuvette and starts to compress. Do not over-tighten.
6. Insert the square end of the USB cable that came with your shipment into the side of the USB2000 spectrometer. Insert the other end into a USB port on your PC.
7. Start OOIBase32.
8. To turn on the light source in the USB-ISS-VIS, select **S2000 Strobe Enabl**e in the OOIBase32 Acquisition Parameters Dialog Bar.

Specifications

Wavelength range:	390-900 nm
Light source:	tungsten bulb, violet LEDs
Bulb life:	45,000 hours
Cuvette holder path length:	1 cm
Lens diameter:	5 mm
Input voltage:	4.2 to 8.0 V
Current:	200 mA
Warm-up time:	5 minutes
Pinouts:	See USB2000 pinouts

ISS Integrated Sampling System

The **ISS Integrated Sampling System** is a fully integrated 1-cm cuvette holder and tungsten halogen light source. It couples to our spectrometers with optical fiber to create a small-footprint systems for VIS-NIR (~360-1100 nm). The ISS has a 10,000 hour bulb and the fan is enclosed in the base.

Parts Included

- ISS cuvette holder and light source assembly
- 12VDC wall transformer for providing power
- 1-cm square, plastic cuvette for holding samples
- Screwdriver for adjusting the fit of the cuvette
- Allen wrench for adjusting the collimating lens

Operation

Attaching the Fibers

1. Attach a SMA-terminated optical fiber to the collimating lens.
2. Attach the other end of this fiber -- the read fiber -- to the spectrometer.

Adjusting the Fit of the Cuvette

The ISS is preset for use with a 1-cm cuvette. When properly adjusted, the cuvette should fit snugly into the holder.

1. Locate the two ball plunger screws.
2. Use the screwdriver to loosen the two ball plunger screws until the ends are visible in the holder.
3. Insert your cuvette into the holder.
4. Tighten the screws until the ball contacts the cuvette and starts to compress. Do not over-tighten.

Installing Filters

1. Loosen the filter clamping screw with an Allen wrench.
2. Insert the filter into the filter slot. The filter slot can accommodate filters up to 6 mm thick.
3. Clamp the filter in place by gently tightening with an Allen wrench.

Turning On the Lamp

1. Plug the wall transformer end into a 110 V outlet. Plug the 12 V output end into the back of your ISS.
2. Screw a fiber into the SMA connector.
3. Find the on/off switch on the back of the lamp and turn the lamp on.

Replacing the Bulb on the ISS

1. Order a replacement bulb.
2. Turn off the lamp and allow it to cool.
3. Use your Allen wrench to loosen the set screw on the bottom of the lamp. You do not need to remove the set screw. This screw holds the bulb in place.
4. Locate the two set screws at the back of the lamp, one above each back leg. These two screws keep the two halves of the lamp together. Remove the two screws.
5. Gently separate the two halves of the lamp and pull the bulb out of its housing.
6. Detach the wire and socket from the lamp leads. Remove the old bulb unit and discard.
7. Plug the new bulb into the socket and slide it forward into the front of the lamp as far as it will go.

8. Tighten the set screw on the bottom of the lamp.
9. Close the two halves without pinching the wires. Replace the two screws at the back of the lamp.
10. Check the lamp output and adjust the focus of the SMA connector, if necessary. See **Appendix B** for instructions on adjusting the focus of your collimating lens.

Specifications

Path length:	1 cm
Collimating lens:	BK 7 glass (~360 nm - 2 μm*), 5 mm diameter, f/2
Collimating lens termination:	SMA 905
Filter slot:	accepts filters up to ¼" (6 mm) in thickness
Base material:	aluminum
Spectral range:	360 nm - 2 μm*
Dimensions:	9.0 cm x 5.0 cm x 3.2 cm (LWH) 3.5" x 2.0" x 1.25" (LWH)
Power input:	12 VDC/800 mA, 7-20 VDC/0.5-2 amps
Power output:	6.5 watts
Bulb life:	10,000 hours
Bulb color temperature:	2800K
Output to bulb:	5 volts/1.3 amps
Output regulation:	0.2% voltage
Time to stabilized output:	~ 30 minutes
Bulb output:	7400 foot-candles (7.4MSCP)

* The useable range of the ISS sampling device is limited to the wavelength range of the spectrometer to which it is coupled -- i.e., though ISS lens is optimized for use to 2 μm, they can be configured to "see" only to 1100 nm with our spectrometers.

ISS-2 Integrated Sampling System

The **ISS-2 Integrated Sampling System** is a fully integrated 1-cm cuvette holder and tungsten halogen light source. It couples to our spectrometers with optical fiber to create a small-footprint systems for VIS-NIR (~360-1100 nm). The ISS-2 has a 900 hour bulb. Also, in the ISS-2, the fan is not enclosed in the base; it is exposed and should be handled with care.

Parts Included

- ISS-2 cuvette holder and light source assembly
- 12VDC wall transformer for providing power
- 1-cm square, plastic cuvette for holding samples
- Screwdriver for adjusting the fit of the cuvette
- Allen wrench for adjusting the collimating lens

Operation

Attaching the Fibers

1. Attach a SMA-terminated optical fiber to the collimating lens.
2. Attach the other end of this fiber -- the read fiber -- to the spectrometer.

Adjusting the Fit of the Cuvette

The ISS-2 is preset for use with a 1-cm cuvette. When properly adjusted, the cuvette should fit snugly into the holder.

1. Locate the two ball plunger screws.
2. Use the screwdriver to loosen the two ball plunger screws until the ends are visible in the holder.
3. Insert your cuvette into the holder.
4. Tighten the screws until the ball contacts the cuvette and starts to compress. Do not over-tighten.

Installing Filters

1. Loosen the filter clamping screw with an Allen wrench.
2. Insert the filter into the filter slot. The filter slot can accommodate filters up to 6 mm thick.
3. Clamp the filter in place by gently tightening with an Allen wrench.

Turning On the Lamp

1. Plug the wall transformer end into a 110 V outlet. Plug the 12 V output end into the back of your ISS-2.
2. Screw a fiber into the SMA connector.
3. Find the on/off switch on the back of the lamp and turn the lamp on.

Replacing the Bulb on the ISS-2

1. Order a replacement bulb.
2. Turn off the lamp and allow it to cool.
3. Remove the fan from the bottom of the lamp by loosening the four screws securing it to the base. Two of the four screws also hold the two front legs in place. Once the screws are loosened, gently pull the fan, along with the legs, away from the lamp.
4. Now that the fan is removed, use an Allen wrench to loosen the set screw that is underneath the fan. This screw holds the bulb in place. You do not need to remove the set screw -- loosening it is sufficient.

5. Locate the two set screws at the back of the lamp, one above each back leg. These two screws keep the two halves of the lamp together. Remove the two screws.
6. Gently separate the two halves of the lamp and pull the bulb out of its housing.
7. Detach the wire and socket from the lamp leads. Remove bulb unit and discard.
8. Plug the new bulb into the socket and slide it forward into the front of the lamp as far as it will go.
9. Tighten the set screw on the bottom of the lamp to hold the bulb in place.
10. Close the two halves of the lamp, being careful not to pinch the wires. Replace the two screws at the back of the lamp and secure the fan to the bottom of the lamp.

Specifications

Path length:	1 cm
Collimating lens:	BK 7 glass (~360 nm - 2 μm*), 5 mm diameter, f/2
Collimating lens termination:	SMA 905
Filter slot:	accepts filters up to ¼" (6 mm) in thickness
Base material:	aluminum
Spectral range:	360 nm - 2 μm*
Dimensions:	9.0 cm x 5.0 cm x 3.2 cm (LWH) 3.5" x 2.0" x 1.25" (LWH)
Power input:	12 VDC/800 mA, 7-20 VDC/0.5-2 amps
Power output:	6.5 watts
Bulb life:	900 hours
Bulb color temperature:	3100K
Output to bulb:	5 volts/1.3 amps
Output regulation:	0.2% voltage
Time to stabilized output:	~ 30 minutes
Bulb output:	7400 foot-candles (7.4MSCP)

* Though the product can be used to 2 μm, it can be configured to "see" only to 1100 nm with our USB2000 spectrometer.

ISS-UV-VIS Integrated Sampling System

The **ISS-UV-VIS Integrated Sampling System** is a combination of a RF deuterium source with a tungsten bulb connected to a cuvette holder for 1-cm cuvettes. The cuvette holder attaches directly to the light source and has a 5-mm diameter f/2 collimating lens. The ISS-UV-VIS can be operated manually or through the software.

Parts Included

- ISS-UV-VIS Integrated Sampling System
- Power cord for connecting the ISS-UV-VIS to outlet
- 15-pin accessory cable for software control of the ISS-UV-VIS

Caution!

- The beam emerging from the ISS-UV-VIS produces ultraviolet radiation. Direct eye contact could cause eye injury. Safety eyewear is recommended.
- Never look directly into the light source or stare at the diffuse reflected beam.
- Dangerous voltages present. NO serviceable parts inside unit. The deuterium and tungsten bulbs cannot be replaced by unauthorized personal. To replace a bulb in the ISS-UV-VIS, contact Ocean Optics.
- For any experiments using UV light, we recommend using our solarization-resistant fiber.
- This instrument should not be used for any clinical or diagnostic purposes.

Operation

Adjusting the Fit of the Cuvette

The ISS-UV-VIS is designed to hold 1-cm square cuvettes. When properly adjusted, the cuvette should fit snugly into the holder.

1. Locate the two ball plunger screws.
2. Use the screwdriver to loosen the ball plunger screws until the ball end of the screw is just visible in the holder.
3. Insert your cuvette into the holder.
4. Gently tighten the screws until the ball contacts the cuvette and starts to compress. Do not over-tighten.

Setting Up the ISS-UV-VIS

1. Attach an optical fiber to the SMA connector on the front of the ISS-UV-VIS and attach the other end of this fiber to the SMA connector on your spectrometer.
2. Plug the wall transformer into a standard 110 V outlet. Plug the 12 V output into the back of your ISS-UV-VIS above the **12V** label. For users of European-version wall transformers, plug the transformer into a standard 220 V outlet. At this time, the green LED indicator light on the front of the lamp will be lit. This indicator light only means that the lamp is receiving power, not that the deuterium and tungsten bulbs are on.

Operating the ISS-UV-VIS Manually

1. Find the switch on the back of the ISS-UV-VIS.
2. There are three positions: On, Off, and Remote. For Manual operation, move the switch to the On position. There can be up to a 1.5 second delay between switching the lamp to on and the bulbs igniting. If the lamp has not been used recently, the deuterium bulb may take up to 60 seconds to ignite.
3. For 0.3% peak-to-peak stability, allow 30 minutes warm-up time before taking your measurements.

Operating the ISS-UV-VIS through Software

1. Connect the 15-pin accessory cable from the spectrometer to the ISS-UV-VIS.
2. Find the switch on the back of the ISS-UV-VIS. There are three positions: On, Off, and Remote. For Software operation, move the switch to the Remote position. Moving the switch to the Remote position enables you to control the lamp through the software, whether you are using OOIChem or OOIBase32 software.
3. When using OOIChem software, select **Spectrometer | Enable Strobe** from the menu to turn it on and off.
4. When you want to control the ISS-UV-VIS through OOIBase32 software, select or deselect the **Strobe Enable** box in the dialog bar above the graph area to turn the bulbs on and off.
5. There can be up to a 1.5 second delay between turning the bulbs on via the software and the bulbs igniting. If the lamp has not been used recently, the deuterium bulb may take up to 60 seconds to ignite.
6. For 0.3% peak-to-peak stability, allow 30 minutes warm-up time before taking your measurements.

Disabling the Tungsten or Deuterium Bulb

It is possible to disable the deuterium or the tungsten bulb in the ISS-UV-VIS. Both bulbs are enabled at the time of manufacture. In order to disable the deuterium or tungsten bulb, you must remove the casing of the ISS-UV-VIS.

Disabling the Deuterium Bulb

Jumper block JA of the ISS-UV-VIS's circuit board controls the deuterium bulb. Short the pins 2-3 (that is, place a jumper over pins 2-3 of JA) to enable the deuterium bulb. Short the pins 1-2 (that is, place a jumper over pins 1-2 of JA) to disable the deuterium bulb.

Disabling the Tungsten Bulb

Jumper block JB of the ISS-UV-VIS's circuit board controls the tungsten bulb. Short the pins 2-3 (that is, place a jumper over pins 2-3 of JB) to enable the tungsten bulb. Short the pins 1-2 (that is, place a jumper over pins 1-2 of JB) to disable the tungsten bulb.

Using Solarization-resistant Fibers

For any experiments using UV light, we recommend using our solarization-resistant fiber. Our 300-µm Diameter Solarization-resistant Optical Fiber consists of a silica core, surrounded by a silica cladding material. The fiber is then coated in aluminum. Our solarization-resistant fibers are best used for regions below 250 nm, or where exposure to long-term UV light occurs. If you do not use solarization-resistant fibers when using a UV light source, the UV radiation degrades the silica in a standard patch cord fiber over time, resulting in increased overall absorption values and invalid data.

Specifications

Deuterium wavelength range:	200-400 nm
Tungsten wavelength range:	360-850 nm
Deuterium bulb life:	800 hours
Tungsten bulb life:	2,000 hours
Ignition delay:	~1.5 seconds to 60 seconds
Peak-to-peak stability:	0.3% in 30 minutes 1.0% in 10 minutes
Connector:	SMA 905
Power input:	12 V
Power requirement:	12 VDC/420 mA
Power consumption:	5 watts (deuterium 3.8 watts, tungsten 1.2 watts)

CUV-UV, CUV-VIS Cuvette Holders

The **CUV-UV** and **CUV-VIS Cuvette Holders** for 1-cm path length cuvettes couple via SMA-terminated optical fibers to our spectrometers and light sources to create small-footprint spectrophotometric systems for absorbance and transmission experiments. These holders can be optimized for UV-VIS-NIR (~200-1100 nm) or VIS-NIR (~360-1100 nm) applications.

Parts Included

- Cuvette holder assembly for holding 1-cm cuvettes
- Black cover for eliminating ambient light
- Two barbed fittings for connecting a temperature stabilizing water source
- Screwdriver for adjusting the fit of the cuvette
- Allen wrench for adjusting the collimating lenses

Operation

Attaching the Fibers

1. Attach one end of a SMA-terminated optical fiber to one of the collimating lenses. Attach the other end of this fiber – the illumination fiber – to a light source.
2. Attach another SMA-terminated optical fiber to the other collimating lens. Attach the other end of this fiber – the read fiber – to the spectrometer.

Using the Fiber Supports

1. Snap the clamps around the fibers after the fibers are screwed into the light source and spectrometer.
2. Lift the clamps until they support the fibers.
3. Unsnap the clamps to remove the fibers.

Installing Filters

1. Loosen the filter clamping screw with the provided screwdriver.
2. Insert the filter into the filter slot. The filter slot can accommodate filters up to 6 mm thick.
3. Clamp the filter in place by gently tightening the clamping screw finger-tight.

Adjusting the Fit of the Cuvette

The Cuvette Holder is designed to hold 1-cm square cuvettes. When properly adjusted, the cuvette should fit snugly into the holder.

1. Locate the two ball plunger screws.
2. Remove the fiber clamps for easier access to the screws.
3. Use the provided screwdriver to loosen the two ball plunger screws until the ball end of the screws is just visible in the cell holder and insert your cuvette into the holder.
4. Tighten the ball plunger screws until the ball contacts the cuvette and starts to compress. Do not over-tighten.

Using the Temperature Stabilization Feature

This feature is used to heat or cool the cuvette holder base and cuvette.

1. Remove the plugs from the top side of the base. (The plug on the right side of the base should stay in place but may require thread tape.)
2. Replace the plugs with the two barbed fittings (or any 1/8" NPT pipe thread fittings). Thread tape may be required on the fittings.
3. Connect the fittings to a water source. Water will circulate through the base.

Specifications

Path length:	1 cm
Collimating lenses (VIS-NIR):	BK 7 glass (~360 nm - 2 μm*), 5 mm diameter, f/2
Collimating lenses (UV-VIS-NIR):	Dynasil 1100 quartz (200 nm-2 μm*), 5 mm diameter, f/2
Collimating lens termination:	SMA 905
Collimating lenses assembly (sample compartment) dimensions:	2.0" x 1.5" (LW)
Filter slot:	accepts filters up to ¼" (6 mm) in thickness
Base material:	aluminum
Base length:	5.5"
Connections in base:	water inlet water outlet extra connection
Water input fittings:	1/8" NPT pipe thread
Typical optical fibers specified for optimum performance (light throughput and optical resolution)**:	200 μm illumination fiber 50 μm read fiber

* Though the VIS-NIR lens is optimized for use to 2 μm, it can be configured to "see" only to 1100 nm with our USB2000 spectrometer.

** There is no single combination of optical fibers that will satisfy the requirements of every application. As a rule, however, it is best to use a large-diameter (>50 μm) illumination fiber to get the maximum light throughput, and a small-diameter (<50 μm) read fiber to achieve the best optical resolution.

CUV-UV-10, CUV-VIS-10 Cuvette Holders

The **CUV-UV-10** and **CUV-VIS-10 Cuvette Holders** for 10-cm cuvettes couple to our spectrometers and light sources to create spectrophotometric systems for absorbance and transmission measurements of aqueous solutions and gases for UV-VIS-NIR (~200-1100 nm) or VIS-NIR (~360-1100 nm) applications.

Parts Included

- Cuvette Holder assembly for holding 10-cm cuvettes
- Black Cover for eliminating ambient light
- Two Barbed Fittings for connecting a temperature stabilizing water source
- Allen wrench for adjusting collimating lenses

Operation

Attaching the Fibers

1. Attach one end of a SMA-terminated optical fiber to one of the collimating lenses. Attach the other end of this fiber -- the illumination fiber -- to a light source.
2. Attach another SMA-terminated optical fiber to the second collimating lens. Attach the other end of this fiber -- the read fiber -- to the spectrometer.

Using the Fiber Supports

1. Snap the clamps around the fibers after the fibers are screwed into the light source and spectrometer.
2. Lift the clamps until they support the fibers. To remove the fibers, simply unsnap the clamps.

Installing Filters

1. Tighten the thumb wheel completely when not using a filter.
2. Loosen the thumb wheel on the left side of the cuvette holder, creating enough space for the filter.
3. Insert the filter into the filter slot, which can hold filters up to 6 mm thick, and tighten the thumb wheel.

Using the Temperature Stabilization Feature

This feature is used to heat or cool the cuvette holder base and cuvette.

1. Remove the two plugs from the top side of the base. (The plug on the right side of the base should stay in place but may require thread tape.)
2. Replace the plugs with the two barbed fittings (or any 1/8" NPT Pipe thread fittings). Thread tape may be required on the fittings.
3. Connect the fittings to a water source. Water will circulate through the base.

Specifications

Collimating lenses (VIS-NIR):	BK 7 glass (~360 nm - 2 μm*), 5 mm diameter
Collimating lenses (UV-VIS-NIR):	Dynasil 1100 quartz (200 nm - 2 μm*), 5 mm diameter
Base material and length:	Aluminum, 5.5"
Water input fittings:	1/8" NPT pipe thread

* Though the VIS-NIR lens is optimized for use to 2 μm, it can be configured to "see" only to 1100 nm with our USB2000 spectrometer.

CUV-ALL 4-way Cuvette Holder

The **CUV-ALL 4-way Cuvette Holder** for 1-cm path length cuvettes has four collimating lenses that couple to optical fibers, light sources, and spectrometers to measure absorbance, fluorescence, scattering, or any combination of these optical phenomena.

Parts Included

- CUV-ALL assembly for holding 1-cm cuvettes
- Black Cover for eliminating ambient light
- Two Barbed Fittings for connecting a temperature stabilizing water source
- Screwdriver for adjusting the fit of the cuvette
- Allen wrench for adjusting the collimating lenses

Operation

Attaching the Fibers for Absorbance Measurements

1. For UV measurements, attach one end of a SMA-terminated optical fiber to one of the collimating lenses with the UV label and a red lens cap. Attach the other end of this fiber to a UV light source. Attach another SMA-terminated optical fiber to the collimating lens directly opposite of the first fiber. It too has a red lens cover. Attach the other end of this fiber to the spectrometer.
2. For VIS measurements, attach one end of a SMA-terminated optical fiber to one of the collimating lenses with the VIS label and a black lens cover. Attach the other end of this fiber to a light source. Attach another SMA-terminated optical fiber to the collimating lens directly opposite of the first fiber. It too will have a black lens cover. Attach the other end of this fiber to the spectrometer.

Attaching the Fibers for Fluorescence Measurements

1. Attach one end of a SMA-terminated optical fiber to one of the collimating lenses. Attach the other end of this fiber to a light or excitation source. Typically, for fluorescence measurements, the illumination fiber connects to a UV lens.
2. Attach another SMA-terminated optical fiber to the collimating lens to the immediate left or right of the first fiber. The two collimators must be positioned at 90° for fluorescence measurements. Attach the other end of this fiber to the spectrometer. Typically, for fluorescence measurements, the read fiber connects to a VIS lens.

Using the Fiber Supports

1. Snap the clamps around the fibers after the fibers are screwed into the light source and spectrometer.
2. Lift the clamps until they support the fibers.
3. Unsnap the clamps to remove the fibers.

Adjusting the Fit of the Cuvette

The CUV-ALL is preset for use with a 1-cm quartz cuvette. When properly adjusted, the cuvette should fit snugly in the holder.

1. Locate the two ball plunger screws. They are under two of the four collimating lenses.
2. Remove the fiber clamps for easier access to the screws.
3. Use the provided screwdriver to loosen the two ball plunger screws until the ball end of the screws is just visible in the cell holder.
4. Insert your cuvette into the holder.
5. Tighten the ball plunger screws until the ball contacts the cuvette and starts to compress. Do not over-tighten.

Installing Filters

1. Loosen the filter clamping screw with the provided screwdriver.
2. Insert the filter into the filter slot. The filter slot can accommodate filters up to 6 mm thick.
3. Clamp the filter in place by gently tightening the clamping screw finger tight.

Using the Temperature Stabilization Feature

This feature is used to heat or cool the cuvette holder base and cuvette.

1. Remove the two plugs from the top side of the base. (The plug on the right side of the base should stay in place but might require thread tape.)
2. Replace the plugs with the two barbed fittings (or any 1/8” NPT pipe thread fittings). Thread tape might be required on the fittings.
3. Connect the fittings to a water source. Water will circulate through the base.

Specifications

Path length:	1 cm
Collimating lenses (VIS-NIR):	(2) BK 7 glass (~360 nm - 2 μm*), 5 mm diameter, f/2
Collimating lenses (UV-VIS-NIR):	(2) Dynasil 1100 quartz (200 nm - 2 μm*), 5 mm diameter, f/2
Collimating lens termination:	SMA 905
Fluorescence option:	position 2 collimators at 90°
Filter slot:	accepts filters up to ¼" (6 mm) in thickness
Base material:	aluminum
Water input fittings:	1/8" NPT pipe thread

* Though the VIS-NIR lens is optimized for use to 2 μm, it can be configured to "see" only to 1100 nm with our USB2000 spectrometer.

CUV-FL-DA Direct Attach Cuvette Holder

The **CUV-FL-DA Direct Attach Cuvette Holder** attaches directly to our light sources and couples via SMA-terminated optical fibers to our spectrometers, creating an incredibly small-footprint spectrophotometric system for fluorescence as well as absorbance experiments. The CUV-FL-DA, optimized for UV-VIS-NIR (200-1100 nm) applications, holds 1-cm square cuvettes.

The CUV-FL-DA is especially useful for fluorescence measurements. Mirrored screw plugs have been incorporated into the CUV-FL-DA to make the fluorescence signal stronger. These mirrors are UV-enhanced aluminum-coated for optimal signal reflection. One mirrored screw plug collects the fluorescence that would otherwise be lost. The second screw plug works to reflect the excitation energy back through the sample. The increase in signal intensity is also a result of the direct attachment of the CUV-FL-DA to the light source.

The CUV-FL-DA has a 74-UV collimating lens to collect the light and funnel it to the fiber. Collection efficiency, spatial resolution, transmission angle, and acceptance (or collection) angle are adjustable and are easily optimized. The CUV-FL-DA is packaged with the collimating lens screwed on at a 90° angle from the light source for fluorescence measurements. However, the lens is removable and can be relocated for "straight-through" absorbance measurements.

Operation

Using with the D-1000 and DT-1000

To attach the CUV-FL-DA to the D-1000 or the DT-1000 the safety shutter must first be removed.

1. Use a Phillips-head screwdriver to remove all 12 screws from the side panels of the D-1000 or DT-1000 casing. **Do not** remove *any* screws from the front, back, or bottom panels. Remove the cover.
2. Remove the screw securing the safety shutter in place.
3. The inner barrel of the collimating lens for the lamp must also be removed. Using the Allen wrench, remove the small silver screw on the inner barrel of the lens and pull out the inner barrel.
4. Place the CUV-FL-DA over the SMA termination and secure the holder to the lamp by gently tightening the set screw on the CUV-FL-DA.

Adjusting the Fit of the Cuvette

The CUV-FL-DA is preset for use with a 1-cm cuvette. When properly adjusted, the cuvette should fit snugly in the holder.

1. Check that the mirrored screws are flush with the inside of the holder (of course the cuvette is absent). If necessary, adjust the mirrored screws so that they are flush with the inside of the holder.
2. Locate the two ball plunger screws.
3. Loosen the two ball plunger screws until the ball end of the screws is just visible in the cell holder.
4. Insert your cuvette into the holder.
5. Tighten the ball plunger screws until the ball contacts the cuvette. Do not over-tighten.

Installing Filters

1. Loosen the filter clamping screw with a screwdriver.
2. Insert the filter into the filter slot. The filter slot can accommodate filters up to 6 mm thick.
3. Clamp the filter with the screwdriver.

Specifications

Path length:	1 cm
Dimensions:	1.4” x 1.4” x 1.0” (L x W x H)
Material:	Black anodized aluminum
Hole diameter for mounting to light source:	0.375”
Collimating lens:	Dynasil 1100 quartz (200 nm - 2 μm), 5 mm diameter
Collimating lens termination:	SMA 905
Filter slot:	accepts filters up to ¼" (6 mm) in thickness
Reflection mirrors:	UV-enhanced, aluminum-coated for optimal signal reflection and collection
Mirror diameter:	0.3” (7.5 mm)
Size of light beam reaching sample:	¼” minimum divergent

USB-FHS Filter Holder

The **USB-FHS Filter Holders** is a low-cost spectrophotometric accessories for fast, convenient absorbance and transmission measurements of optical and other filters. Optimized for VIS-Shortwave NIR (~390-900 nm) measurements, each holder has a 5-mm diameter f/2 collimating lens to maximize light throughput.

The USB-FHS Filter Holder accepts round or square optical filters. The light that passes through the filter is collimated. This process makes it possible to measure either glass or interference filters.

Operation

1. Remove power from the USB2000 by either disconnecting it from the PC to which it is interfacing or detaching the power cord.
2. Snap on the USB-FHS to the front of the USB2000 spectrometer.
3. Insert your filter into the holder.
4. Locate the ball plunger screw that holds the filter in place. Tighten the ball plunger screw to secure the filter. Do not over-tighten.
5. Insert the square end of the USB cable that came with your shipment into the side of the USB2000 spectrometer. Insert the other end into a USB port on your PC.
6. Start OOIBase32.
7. To turn on the light source in the USB-FHS, select **S2000 Strobe Enable** in the OOIBase32 Acquisition Parameters Dialog Bar.

Specifications

USB-FHS-VIS Collimating lenses (VIS-NIR):	5 mm diameter, f/2
Wavelength range:	390-900 nm
Light source	tungsten bulb, violet LEDs
Bulb life:	45,000 hours
Input voltage:	4.2 to 8.0 V
Current:	200 mA
Warm-up time:	5 minutes

FHS-UV and FHS-VIS In-line Filter Holders

The **FHS-UV** and **FHS-VIS In-line Filter Holders** are low-cost spectrophotometric accessories for fast, convenient absorbance/transmission measurements of optical and other filters. Optimized for VIS-Shortwave NIR (~360-1000 nm) or UV-VIS-Shortwave NIR (200-1100 nm) measurements, each holder has a pair of 5-mm diameter f/2 collimating lenses to maximize light throughput, and comes with a manual light-block wheel for taking dark readings.

The FHS In-line Filter Holder accepts 1" round or any size >1/2" square optical filters, up to ¼" (6 mm) in thickness. Plastic supports hold SMA-terminated fibers steady during use. The light that passes through the filter is collimated. This process makes it possible to measure either glass or interference filters.

Operation

Installing Filters

1. Loosen the filter thumb wheel on the left side of the filter holder to create enough space for the filter you wish to use.
2. If the filter is round, place it in the filter slot.
3. If the filter is square, place it in the filter slot at a 45° angle, so the filter is in the beam path.
4. Clamp the filter in place by tightening the thumb wheel.
5. When filters are not being used in the holder, tighten the thumb wheel completely.

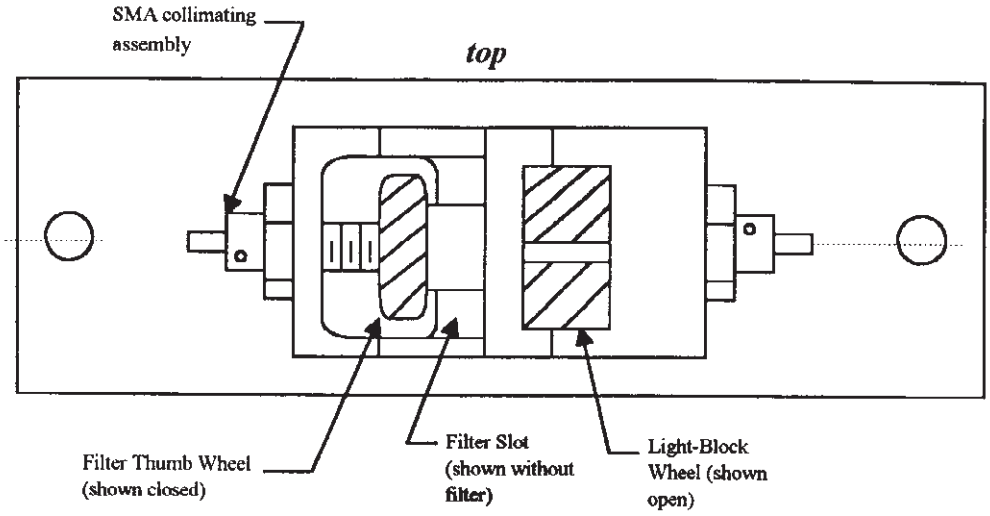
Using the Fiber Supports

1. Snap the clamps around the fibers after the fibers are screwed into the light source and spectrometer.
2. Lift the clamps until they support the fibers.
3. Unsnap the clamps to remove the fibers.

Using the Shutter

Use the shutter to take dark readings.

- The shutter is in the OPEN position when the knurled light-block wheel shows a scored depression (shown open on the drawing).
- The shutter is in the CLOSED position when the light-block wheel is rotated so only the knurling shows (the wheel will lock into this position with a positive action).



Specifications

FHS-VIS Collimating lenses (VIS-NIR):	BK 7 glass (~360 nm - 2 μm*) 5 mm diameter f/2
FHS-UV Collimating lenses (UV-VIS-NIR):	Dynasil 1100 quartz (~200 nm - 2 μm*) 5 mm diameter f/2
Collimating lens termination:	SMA 905
Filter slot:	accepts filters 1" round or any size >1/2" square, up to 1/4" (6 mm) in thickness
Base material:	aluminum

* Though the product can be used to 2 μm, it can be configured to "see" only to 1100 nm with our USB2000 spectrometer.

LPC Long Pass Flow Cells

LPC Long Pass Flow Cells from Ocean Optics couple to the company's high-sensitivity fiber optic spectrometers and compact light sources via SMA terminations for simple, efficient measurement of low-volume or low-concentration (ppb-ppt) aqueous samples. LPC Long Pass Flow Cells are available in 1-meter, 5-meter and 10-meter path lengths for absorbance measurements. The Flow Cells will function with most liquids (except for perfluorinated solvents) having a refractive index ≥1.30.

Caution!

- Do not use perfluorinated solvents with the LPC because the amorphous fluoropolymer tubing is soluble in these chemicals.
- LPC Flow Cells will function with most liquids (except for perfluorinated solvents) having a refractive index ≥1.30.
- Ensure the plumbing fittings through the front panel are tight and free of leaks.
- Minimize the injection of bubbles into the LPC since they will cause erratic results. Continuous pumping will typically flush the bubbles through the system.
- At the end of each experimental session, flush the system with solvent and then pump dry. Avoid leaving fluid in the LPC for extended periods of time.
- DO NOT exceed a fluid pressure of 45 psi.

Operation

Using the Plumbing Connections

On the front panel, there are two plumbing feed-through ports. It does not matter which one is used for the plumbing input or the plumbing output. However, for experimental consistency, once you have assigned which fitting will be the plumbing input and which one will be the plumbing output, try not to switch the plumbing configuration. The tubing goes over the plumbing fittings, which are standard ¼-28 threads. The tubing should fit snugly over the fittings and be free of leaks.

1. Attach one end of the tubing to your pump. The pump used must not pump the solution so fast that the fluid pressure exceeds 45psi. Remember to always turn off the pump in between taking a reference and taking sample measurements.
2. Make sure you have a proper waste receptacle for the other end of the tubing.

The plumbing connections inside the LPC are standard industry fittings. No maintenance should be required. However, if leaks develop, the plumbing connections will need to be tightened. To tighten the connections, simply follow these steps:

1. Remove the back panel.
2. Carefully slide off the top cover, being careful not to damage or pinch the tubing or fiber.
3. Hand-tighten the fittings and reassemble the cover and back panel.

Installing Fibers

On the front panel, there are two fiber feed-through ports. It does not matter which one is used for the fiber input or the fiber output. However, for experimental consistency, once you have assigned which fiber port will be the input and which one will be the output, try not to switch the fiber configuration. The fiber inside the LPC has a core diameter of 200 µm. External coupling fibers should be 200 µm or larger for maximum coupling efficiency.

1. Attach one end of an illumination fiber to a port on the LPC and the other end to your light source.
2. Attach one end of a read fiber to the second port on the LPC and the other end to your spectrometer.

Assessing if the LPC is Free of Particles

Fluids need to be relatively particle-free. Particles larger than 20 µm can be trapped inside the tubing and can then block or scatter a significant amount of light. To rid the LPC of particles, follow these steps:

1. Pump the sample fluid through the LPC.
2. While in Scope Mode, save a dark spectrum with the light source off and a reference spectrum with the light source on.
3. Continue to pump the sample fluid and switch to the Absorbance Mode. Ideally, you should see a spectrally flat line. Particle effects manifest themselves as an exponentially decreasing curve from shorter to longer wavelengths. The length of time that you pump the sample and the magnitude of the absorbance peak, depends upon the time required and the minimum detectable absorbance value for your specific analysis. Pre-filtering of the sample may be required to eliminate this exponentially decreasing absorbance spectrum if it is significant to your analysis.

Specifications

Path lengths:	1-meter, 5-meter and 10-meter options (standard); custom lengths also available
Tubing:	Teflon® Amorphous Fluoropolymer 2400 ~560 µm inner diameter, ~800 µm outer diameter
Refractive index:	1.29
Internal volume:	250 µl/meter
Chemical resistance:	tubing can be altered by perfluorinated solvents, FREON® 113, and Perclene®
Recommended optical fibers for coupling to spectrometers, light sources:	400 µm illumination fiber (UV-VIS) 200 µm or 400 µm read fiber (UV-VIS)
Plumbing fittings:	standard ¼" x 28 chromatography fittings

CUV-CCE Electrophoresis Sample Cell

The **CUV-CCE Electrophoresis Sample Cell** for chromatography and capillary electrophoresis is an optical fixture for measuring the UV absorbance of fluids in chromatography or capillary electrophoresis systems. The cell is attached on-line, i.e., the light is projected through the sides of fused silica tubing without violating the tube integrity. For this reason, there are no pressure limitations associated with the device. The cell can accommodate fused silica tubing up to 500 µm in diameter. The user must provide a clear optical window. For standard polyimide-jacketed tubing, this can be accomplished by burning off a short section of the jacketing. The CUV-CCE comes with F230 0.016" ID tubing sleeves. If your tubing is a different size, you can order sleeves with different inner diameters.

The cell fixture is made from a standard 10-32 PEEK™ Cross (Upchurch # P-729) with a 0.02" through-hole, 10-32 coned female threads and (4) F-300 PEEK finger-tight fittings. The optical fibers are aluminum-jacketed, 300-µm diameter, solarization-resistant, silica-core/silica-clad UV waveguides. The optical fibers are inserted facing each other across the sample tubing, and secured with the same F230 0.016" ID tubing sleeves and finger-tight fittings.

Operation

Eliminating Polyimide Jacketing

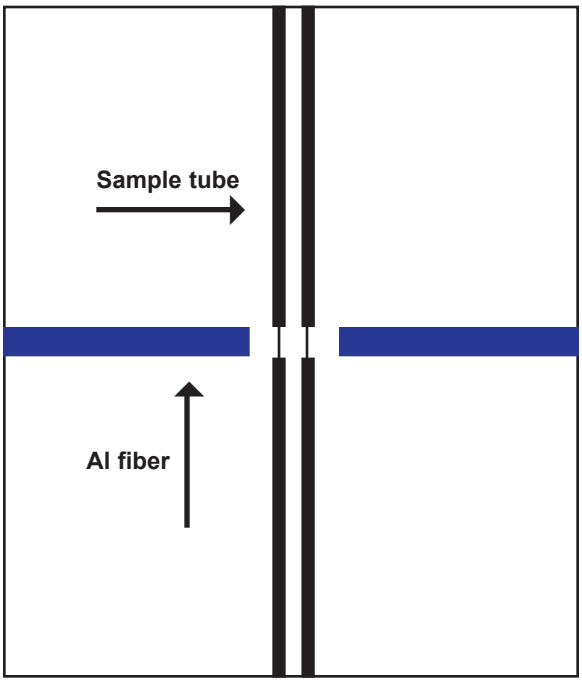
1. Prepare the silica sample tube by burning off the polyimide jacketing with a match or butane lighter.
2. Make sure the tube has completely cooled and then rinse the tubing to remove any burn residue, particles, etc.

Inserting the Sample Tubing

1. Insert the sample tubing through a finger-tight 10-32 fitting and tubing sleeve. Carefully feed the tube through the through-hole of the cross, until the clear window is approximately at the center point of the cross.
2. Tighten the 10-32 fitting until the tube is just snug enough to stay in place. Do not over-tighten.
3. Install the other 10-32 fitting and sleeve on the tubing and into the cross. Leave this fitting loose for now.

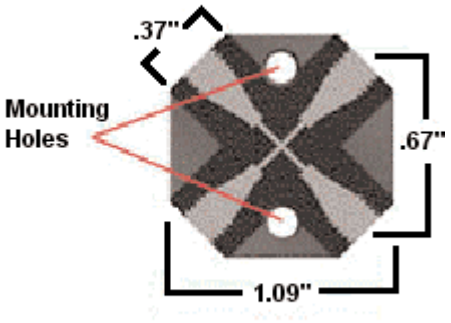
Configuring the Optical Fibers

1. The optical fiber may already be installed in the cross. If it is not, insert the fiber through a 10-32 fitting and tubing sleeve. Insert the fiber into the through-hole of the cross, pushing it gently until it makes contact with the sampling tube. Back the fiber off just enough to leave the sample tube free to manipulate. Tighten the finger-tight fitting to hold the fiber firmly. Do the same for the other fiber as well.
2. Connect one fiber to the SMA connector on a deuterium source (we recommend the DT-1000 for UV/VIS work, or the D-1000 for UV only).
3. Connect the other fiber to the spectrometer (we recommend a unit with an L2 lens and either grating #1 or #2, a 25 µm slit, the UV2 detector upgrade and an OFLV 200-850 order-sorting filter).



Checking the Alignment

1. With the spectrometer running, observe the signal in Scope Mode. When the optical window is properly positioned, you can see a full UV transmission through the cell. If the polyimide is in the optical path, you will see just the red end of the spectra. If this occurs, loosen the fittings and slide the sample tube to align with the window until you achieve the best signal (on both the wavelength and intensity axes).
2. If the fibers are not properly inserted in the through-hole, the intensity will be low. To maximize intensity, loosen the fiber fittings and adjust the fiber.
3. When the fibers and sample tubing are perfectly aligned, make sure all fittings are snug.
4. Mount the cell in your apparatus using the mounting holes. It is important that the optical fibers are not moved during measurements. If necessary, secure the optical fibers to relieve stress, especially where the fibers connect to the cell.



P • 729 Peek™ Cross

Performing CUV-CCE Measurements in OOIBase32

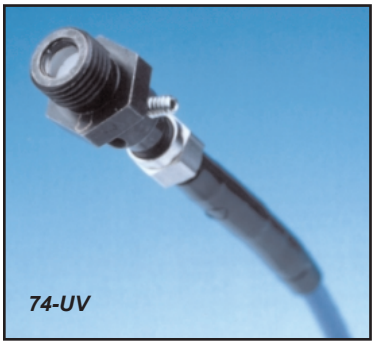
1. Make sure you are in Scope Mode. Select boxcar smoothing and signal averaging values and an integration period that won't saturate the detector.
2. While still in Scope Mode, take a dark spectrum by first disconnecting the optical fiber from the lamp. Take the dark reading by clicking the store dark spectrum icon on the toolbar or selecting **Spectrum | Store Dark** from the menu.
3. Fill the tube with the blank solution or solvent. The peak intensity of the reference signal should be about 3500 counts. Take a reference spectrum by first making sure nothing is blocking the light path going to your sample. Take the reference reading by clicking the store reference spectrum icon on the toolbar or selecting **Spectrum | Store Reference** from the menu.
4. Reconnect the optical fiber to the lamp.
5. Switch from Scope Mode to Absorbance Mode.
6. The data can viewed as a time series of values from a single wavelength, an integrated band around a wavelength, or a mathematical combination of wavelengths. Consult the directions in the **OOIBase32 Spectrometer Operating Software Manual** for using the time series functions.

Specifications

Dimensions:	1.09" x 1.09"
Maximum fused silica tubing allowed:	500-µm in diameter
ID tubing sleeves:	F230 0.016"
Cell fixture:	10-32 PEEK Cross (Upchurch # P-729)
Through-hole size:	0.020"
Coned female threads:	10-32
Fingertight fittings:	F-300 PEEK
UV waveguide optical fibers:	Al-jacketed, 300-µm diameter, solarization-resistant, silica-core/silica-clad
Path length:	silica tubing diameter
Size of light beam reaching sample:	~5 mm (circular)

Sampling Optics

Ocean Optics offers numerous spectroscopic accessories. A short description for each accessory featured in this manual is listed below.


74-UV

- The **74-UV** and **74-VIS Collimating Lenses** screw onto the end of SMA-terminated optical fibers and other sampling optics to convert divergent beams of radiation (light) into a parallel beam.

- The **74-90-UV Right Angle Reflector** for collimating lenses has a mirror located under its cap that reflects light from the collimating lens to 90°. The 74-90-UV is a 3/8-24 threaded black anodized aluminum assembly for mounting our collimating lenses at right angles, and is useful for applications that involve limited space and inconvenient optical fiber routing.

74-90-UV

- The **74-OPM Optical Post Mount** is a 3/8-24 threaded black anodized aluminum assembly used for mounting collimating lenses on breadboard laboratory tables, rail carriers and other bench plates.

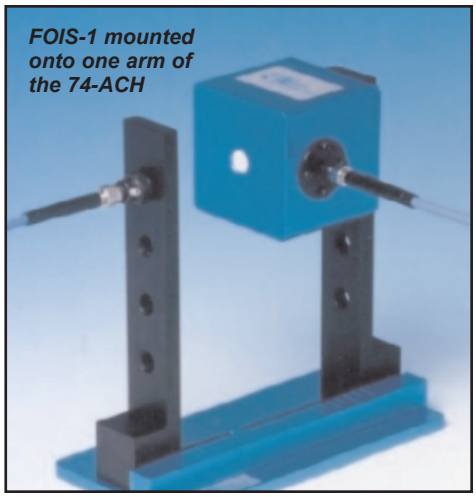
- The **74-ACH Adjustable Collimating Lens Holder** is a versatile assembly for mounting lenses at multiple positions, and is especially useful for large or thick samples not easily accommodated by other sampling optics such as our FHS-UV and FHS-VIS In-line Filter Holders.

- The **FVA-UV Fiber Optic Variable Attenuator** is an opto-mechanical device that controls the amount of light being transmitted by a fiber and the amount of light entering the optical bench of the spectrometer. The attenuator can be used for applications where more light reaches the spectrometer than likely can be digitized successfully by the spectrometer's high-sensitivity linear CCD-array detector. The FVA-UV attenuates light uniformly at all wavelengths.

- The **WS-1 Diffuse Reflectance Standard** is a compact physical standard for use in performing reference measurements for diffuse reflectance applications, especially color analysis. The reflectance material in the WS-1 is Spectralon, a substance that provides a nearly 100% diffuse reflective surface.

- The **ISP-REF Integrating Sphere** is an illuminated integrating sphere that couples via optical fiber to our spectrometers to measure reflectance or emission. The ISP-REF has a transfer optic assembly for restricting the fiber viewing angle, a 0.4" aperture sample port, and a built-in tungsten light source.

- The **FOIS-1 Fiber Optic Integrating Sphere** was designed for emission experiments -- such as measuring the spectral properties of LEDs and other light sources. The FOIS-1 consists of a 1.5" Spectralon sphere encased in an aluminum housing, with a 0.375" input port that accepts light energy from 200-1100 nm and an SMA connector for coupling to the spectrometer. The FOIS-1 also has threads for mounting the unit in a variety of configurations.


FOIS-1 mounted onto one arm of the 74-ACH

74-UV, 74-VIS Collimating Lenses

In order to obtain accurate data, the light entering the sample and the light collected after exiting the sample must be well collimated. The **74-UV** and **74-VIS Collimating Lenses** screw onto the end of SMA-terminated optical fibers and other sampling optics to convert divergent beams of radiation (light) into a parallel beam.

Application Tips

- Using a collimating lens is easy. Screw a collimating lens onto the end of any SMA-terminated port to collect, shape, or focus light.
- Collimating lenses are useful for any optical setup that requires the acceptance or transmission of parallel beams of light at the illumination source, at the entrance optics, or at both ends (illumination and read) of the setup. That's important because the optical fibers Ocean Optics specifies for use with its spectrometers and light sources have a field of view (FOV) of ~25° -- an acceptance angle that may not be appropriate for some experiments. Collimating lenses are adjustable, providing FOV angles from collimation (near 0°) to ~45°. Without the collimating lenses, the light would disperse more than is required for efficient transmission and collection of the signal.

For directions on adjusting the focus of a collimating lens, see **Appendix B**.

Specifications

Lens diameter:	5 mm
Lens length:	10 mm
f-number:	f/2
74-UV material:	Dynasil 1100 quartz (200 nm - 2 μm*)
74-VIS material:	BK 7 glass (360 nm - 2 μm*)
Lens barrel:	stainless steel with black oxide finish
Threads:	UNC 3/8-24

* Though the product can be used to 2 μm, it can be configured to "see" only to 1100 nm with our USB2000 spectrometer.

74-90-UV Right Angle Reflector

The **74-90-UV Right Angle Reflector** is a 3/8-24 threaded black anodized aluminum assembly for mounting collimating lenses at right angles, and is useful for applications involving limited space and inconvenient optical fiber routing.

Application Tips

- The 74-90-UV Right Angle Reflector has a plane mirror located under its cap that reflects light from the collimating lens to 90°. This mirror is coated with a UV-enhanced aluminum substrate that is >90% reflective from 200-1100 nm.
- The 74-90-UV has two 3/8-24 threaded ports -- at top and bottom -- that accommodate collimating lenses. The top port has a 3/8" x 1" threaded nipple that can be removed for connecting to a male adapter.
- Using the 74-90-UV is easy. Screw in a collimating lens into a port and attach a fiber to the collimating lens.

For directions on adjusting the focus of a collimating lens, see **Appendix B**.

Specifications

Assembly material:	black anodized aluminum
Dimensions:	0.65" x .065" x 0.787" (LWH)
Mirror coating:	UV-enhanced aluminum
Mirror reflectivity:	>90% from 200-1100 nm
Threads:	3/8-24 (ports) 3/8 x 1" (nipple)

74-OPM Optical Post Mount

The **74-OPM Optical Post Mount** is a 3/8-24 threaded black anodized aluminum assembly used for mounting collimating lenses on breadboard laboratory tables, rail carriers and other bench plates.

Application Tips

- The 74-OPM Optical Post Mount has an 8-32 x ½" bore for mounting collimating lenses on breadboard laboratory tables, rail carriers and other bench plates. The 74-OPM is 1-1/2" in diameter and 0.4" thick, and can be used to mount lenses securely in place, in a variety of positions.
- Mount the Optical Post Mount onto a post for your laboratory breadboard or any other bench plate. Post and screw are not included.
- Screw a collimating lens into the Optical Post Mount.

Specifications

Assembly material:	black anodized aluminum
Dimensions:	1-1/2" diameter x 0.4" thick
Threads:	3/8-24
Bore for mounting:	8-32 x ½"

74-ACH Adjustable Collimating Lens Holder

The **74-ACH Adjustable Collimating Lens Holder** is a versatile assembly for mounting lenses at multiple positions, and is especially useful for transmission measurements of large or thick samples not easily accommodated by other sampling optics such as our FHS-UV and FHS-VIS In-line Filter Holders.

Application Tips

- The 74-ACH consists of an anodized aluminum base and adjustable mount bars.
- Each bar has four 3/8-24 threaded holes, spaced 1" apart starting 1" from the top of the bar, to accommodate collimating lenses.
- The bars can be adjusted on the base by loosening two 10-32 threaded set screws with a 5/32" hex-head wrench (not included).
- The bars can be set far enough apart to accept samples up to ~10 cm thick.
- The base is scored at ½ cm intervals as a path length guide.

Specifications

Assembly material:	base is blue anodized aluminum mount bars are black anodized aluminum
Dimensions:	base is 3" x 6" x ¼" thick mount bars are 1" wide x 0.3" thick entire assembly is 6" in height
Threads:	mounting bars accept 3/8-24 threads set screws for mounting bars have 10-32 threads (use 5/32" hex-head wrench to loosen)
Measurement bar:	has ½ cm gradations as path length measurement guide (total length is 10 cm)

FVA-UV Fiber Optic Variable Attenuator

The **FVA-UV Fiber Optic Variable Attenuator** is an opto-mechanical device that controls the amount of light entering the optical bench of the spectrometer. Each end of the attenuator has SMA 905 terminations for connecting the attenuator to light sources, sample holders, and fibers. The FVA-UV attenuates light uniformly at all wavelengths.

Application Tips

- The attenuator can be used for applications where more light reaches the spectrometer than likely can be digitized successfully by the spectrometer's high-sensitivity linear CCD-array detector. Some absorbance experiments may also require signal attenuation, as too much light can saturate the reference measurement.
- In some instances, detector saturation can be avoided by adjusting (through software) the spectrometer integration time to limit the interval during which the detector collects light -- somewhat akin to changing the shutter speed on a camera to a faster exposure time. Other options include using different gratings, changing the optical bench entrance aperture (by installing slits or using small-diameter optical fibers), or adding neutral-density filters to the optical path. The FVA-UV fits in where these intensity-reduction techniques are either unworkable or undesirable.

Operation

- The attenuator comes with two collimating lenses, one screwed in at each side. The thumb wheel position is held with the set screw.
- A 6-32 white nylon screw pinches the mechanical adjustment wheel. Loosening the white nylon screw allows the mechanical adjustment wheel to be turned. When the wheel is positioned to your liking, tighten the white nylon screw to keep the wheel in place during your measurement. The wheel is placed between two Teflon washers to provide smooth operation and is knurled along the edge for fingertip gripping.
- To completely close the attenuator, turn the wheel to the white line marking and tighten the white nylon screw.

Using the Adapters

With the FVA-ADP-UV and FVA-ADP-VIS, users can connect the attenuator directly to any light source having a collimating lens at its aperture. To use these adapters, follow these steps:

1. Use an Allen wrench to loosen the set screw of one of the collimating lenses on the attenuator and take out the inner barrel.
2. Slip in the adapter and tighten the set screw.
3. Loosen the set screw on the collimating lens of the light source. Remove the inner barrel of the lens and slide the adapter/attenuator into the collimating lens. Tighten the set screw.

Specifications

Dimensions:	1.5" x 1.5" x 1.0"
Assembly ports:	3/8-24 threads for collimating lenses
Adjustment wheel:	diameter = 3/32" material = black anodized aluminum with knurled edge
Adjustment wheel lock:	6-32 Nylon thumb screw
Connector:	SMA 905

WS-1 Diffuse Reflectance Standard

The **WS-1 Diffuse Reflectance Standard** is a compact physical standard for use in performing diffuse reflectance measurements, especially color analysis. The reflectance material that comprises the WS-1 is Spectralon, a highly lambertian thermoplastic substance that provides a nearly 100% diffuse reflective surface for applications from 200 nm to 2.5 µm. (With an Ocean Optics spectrometer, the practical use of the WS-1 is limited to 200-1100 nm.) The reflective area of the WS-1 is 1.25" in diameter. The diffusing material is encased in a small, black receptacle with a screw-on top.

Operation

Reflection is the return of radiation by a surface, without change in wavelength. Reflection is expressed as a percentage relative to the reflection from a standard substance, such as the WS-1 white reference material. The WS-1 is mostly used in a setup with a reflection probe and reflection probe holder for diffuse reflection measurements or with the ISP-REF Integrating Sphere. To use the WS-1 as a reference in a diffuse reflection measurement:

1. Make sure you are in Scope Mode, by either clicking the **Scope Mode** icon on the toolbar, or selecting **View | Scope Mode**. Take a reference spectrum by first making sure nothing is blocking the light path going to your reference. Place the reflection probe over the WS-1. For best results, use our Reflection Probe Holder to keep the reflection probe firmly at a 45° angle.
2. Take the reference reading by clicking the **Store Reference Spectrum** icon on the toolbar or selecting **File | Store Reference Spectrum**.

Specifications

Reflectance material:	Spectralon
Reflectivity:	>99%
Wavelength range:	200 nm - 2.5 µm*
Reflective area diameter:	1.25"

* Though the product can be used to 2.5 µm, it can be configured to "see" only to 1100 nm with our USB2000 spectrometer.

ISP-REF Integrating Sphere

The **ISP-REF Integrating Sphere** is an illuminated sampling optic that couples via optical fiber to Ocean Optics miniature fiber optic spectrometers to measure reflectance of solid objects or emission of spectral sources. The ISP-REF Integrating Sphere has a transfer optic assembly for restricting the fiber viewing angle, a 0.4" aperture sample port, and a built-in light source (tungsten halogen) with 12-volt DC adapter.

Application Tips

- The ISP-REF has two primary functions: 1) to provide even surface illumination for reflectance measurements, such as determining the color of flat surfaces; and 2) to collect light and funnel it to an optical fiber for emission experiments, such as measuring the spectral properties of an LED.
- The ISP-REF is small and compact -- it's just 2.11" x 2.25" x 3.25" (LWH) and weighs less than 1 pound -- yet is durable enough for use outside the laboratory. All instrument electronics -- including the lamp, which can be replaced by simply removing two screws -- are mounted into the bottom section of the unit.
- The sphere is made from Spectralon, a white diffusing material that provides a highly lambertian reflecting surface. A simple switch allows users to manipulate the sampling optic for the inclusion (I) or exclusion (E) of specular reflectance.
- The reflectivity value obtained by calculating the difference between the inclusion and exclusion of specular reflection is a direct measurement of the gloss of the surface.

Operation

1. Locate the on/off switch on the front of the lamp. The “1” position is the on position. The “0” position is the off position. Turn the lamp on.
2. Locate the shutter switch. It is located on the back of the sphere. The “I” (for includes) position means that the resulting reflection measurement includes both specular and diffuse reflections. The “E” (for excludes) position means that the resulting reflection measurement excludes specular reflection (the user will only obtain diffuse reflection measurements). Move the switch to the mode necessary for your application.

Using the Optical Fiber Ports

- The ISP-REF has SMA connectors for two optical fibers. The connector, or port marked “S” (for sample) is used to couple an optical fiber to the spectrometer to measure the reflection from a flat surface.
- The second port, marked “R” (for reference), offers two features not available with most other integrating spheres. One function of the R port is to couple an optical fiber to a second channel in the spectrometer. This channel can be used to monitor the Integrating Sphere's built-in tungsten halogen lamp, which provides even surface illumination. The other function of the R port is for the coupling of an optical fiber to collect light. This may be advantageous for applications involving the collection of a wide-angle beam of light, especially where the beam is much larger than the size of the entrance optics.

Specifications

Spectral range (of illumination source):	~360-1000 nm
Dimensions:	2.11" x 2.25" x 3.25" (LWH)
Sphere diameter:	1.5"
Sample port aperture:	0.4"
Sphere material:	Spectralon
Reflectance measurements:	specular included or excluded
Bulb life:	900 hours
Bulb color temperature:	3100K

FOIS-1 Fiber Optic Integrating Sphere

The **FOIS-1 Fiber Optic Integrating Sphere** is a sampling optic that accepts light energy through its 0.375" input port and funnels it to an optical fiber for emission experiments -- such as measuring the spectral properties of LEDs and other light sources. The FOIS-1 consists of a 1.5" Spectralon sphere encased in an aluminum housing, with a 0.375" input port that accepts light energy from 200-1100 nm and a SMA connector for coupling to the spectrometer.

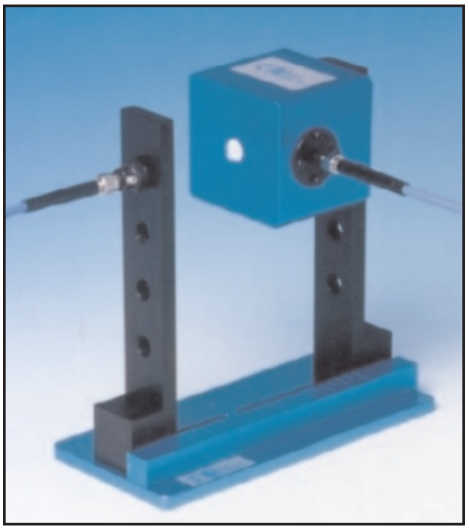
Application Tips

- The FOIS-1 is small and compact -- it's just 2.25" x 2.25" x 2.125" and weighs less than 1 pound -- yet is durable enough for use outside the laboratory.
- The inside of the FOIS-1 is made from Spectralon, a white diffusing material that provides a highly lambertian reflecting surface.

Operation

The FOIS-1 is very easy to operate.

1. Connect an optical fiber (the read fiber) from the FOIS-1's SMA-terminated output port to the SMA termination of the spectrometer.
2. Insert your emission source into the 0.375" black input port of the FOIS-1. Or, configure your setup so that the emission source is aligned so that the light energy can enter the input port.
3. To collect radiation (light) from a 180° field of view, thus eliminating light collection interface problems inherent to other sampling devices, make sure that you do not insert your emission source too deeply into the FOIS-1. If you insert the emission source into the FOIS-1 to the point where it interferes with the SMA-terminated output port, you will not collect radiation from a 180° field of view.
4. Use the 2 mounting holes for mounting the FOIS-1 to other components. There is a 1/4"-20 threaded hole and an 8-32 threaded hole.



FOIS-1 mounted onto one arm of the 74-ACH

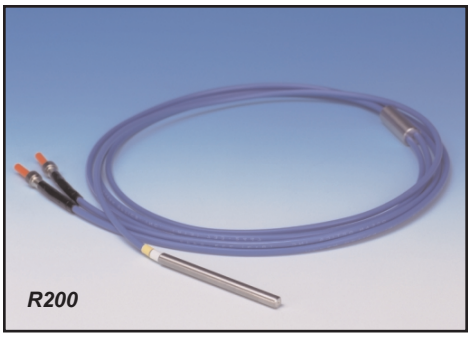
Specifications

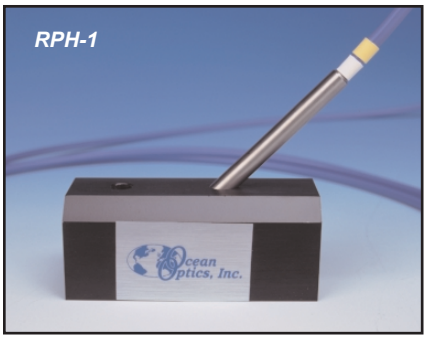
Spectral range:	200-1100 nm
Dimensions:	2.25" x 2.25" x 2.125" (LWH)
Sample port aperture:	0.375"
Sphere coating:	Spectralon
Top cap mounts:	(2) 6-32 threaded holes (2) 8-32 threaded holes (1) 1/4"-20 threaded hole in center
Side mounts:	SMA connector for coupling optical fiber to the spectrometer 8-32 threaded holefor 74-OPM Optical Post Mount
Connector:	SMA 905

Fiber Optic Probes and Accessories

Ocean Optics fiber optic probes couple to our miniature fiber optic spectrometers and light sources to create a variety of optical-sensing systems. Each probe consists of silica-core, silica-clad optical fiber (0.22 NA) and a sampling optic, and are available for UV-VIS (high OH content) or VIS-NIR (low OH content) applications. All standard fiber optic probes are 2 meters in length and have SMA terminations. Custom probe assemblies are also available.

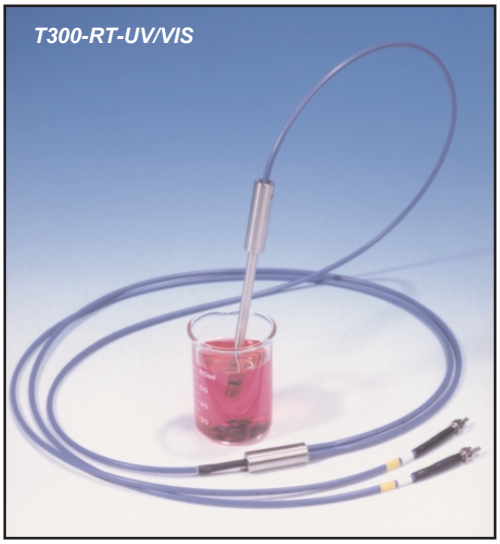
- **R200 Reflection Probes** couple to Ocean Optics miniature fiber optic spectrometers and light sources to create small-footprint optical-sensing systems for fluorescence and reflection measurements. Ocean Optics offers several variations on the Reflection Probe.





- The **RPH-1 Reflection Probe Holder** is an anodized aluminum platform with machined holes at 45° and 90° to hold our R200 Reflection Probes or other 0.25” O.D. probes during reflection measurements such as measuring the reflection properties of mirrors and anti-reflection coatings, and measuring the visual properties of color in paints, graphic arts, plastics, food products, etc..

- The **T300-RT-UV/VIS Transmission Dip Probe** couples to our spectrometers and light sources to create optical-sensing systems for measuring transmission in chemical solutions and other liquids. The standard T300-RT-UV/VIS has (2) 300 µm diameter solarization-resistant fibers (1 illumination, 1 read), 5.0" x 0.25" OD stainless steel ferrule and comes with removable tips, in path lengths of 2 mm, 5 mm or 10 mm.



- The **CC-3 Cosine-corrected Irradiance Probes** are spectroradiometric sampling optics designed to collect radiation (light) from a 180° field of view, thus eliminating light collection interface problems inherent to other sampling devices. The **CC-3 Cosine-corrector** (300-1000 nm) has glass diffusing material. The **CC-3-UV Cosine-corrector** (200 nm to 2 µm) has Teflon diffusing material. Both cosine correctors have a 0.25" O.D. barrel with a smooth yet rugged black oxide finish.

- The **FL-400 Flame-resistant Fiber Probe** is a heat-resistant fiber optic probe that couples to Ocean Optics miniature fiber optic spectrometers to measure *in situ* emission spectra of samples such as dissolved metals and high-temperature plasmas. The FL-400 is a high-temperature 400 µm gold-jacketed UV-VIS optical fiber in an 8" long nickel sleeve. It can operate in environments up to 750º C. The probe accepts a standard wire loop for emission measurements of dissolved metals.

R200 Reflection Probes

R200 Reflection Probes couple to Ocean Optics miniature fiber optic spectrometers and light sources to create small-footprint optical-sensing systems for fluorescence and reflection measurements. Ocean Optics offers several variations on the Reflection Probe:

- The **R200-7 Reflection Probe** consists of a bundle of 7 optical fibers -- 6 illumination fibers around 1 read fiber -- each of which is 200 µm in diameter. A 3.0" x 0.25" stainless steel ferrule houses the fiber bundle. Other options of this standard probe assembly include the **R400-7**, which has a bundle of optical fibers 400 µm in diameter, and the **RP200-7**, which has a 3.0" x 0.25" plastic ferrule to house the fiber bundle. The RP200-7 is useful where a stainless steel ferrule may not be suitable, such as some applications involving corrosive samples.
- For reflection experiments across the UV-VIS-Shortwave NIR (200-1100 nm), there is the **R200-MIXED**. The R200-MIXED consists of fourteen 200 µm-diameter optical fibers -- 6 UV/VIS and 6 VIS/NIR illumination fibers, plus 1 UV/VIS fiber and 1 VIS/NIR read fiber. In addition, the R200-MIXED has a 3.0" x 0.25" stainless steel ferrule to house its fiber bundles, and couples easily to a dual-channel spectrometer in which each channel is set for a different wavelength range.
- Also available is the **R200-REF**, which consists of an R200-7 Reflection Probe and an additional fiber optic to monitor an illumination source such as our LS-1 Tungsten Halogen Light Source. The R200-REF is useful when a reflection experiment either does not allow the user to take frequent reference scans or includes an illumination source with an unstable spectral output.
- One other option is the **R200-ANGLE Reflection Probe**, which has a bundle of seven 200-µm fibers -- 6 illumination fibers around 1 read fiber -- and a 3.0" x 0.25" stainless steel ferrule with a 45° window. This angled window removes the effects of specular reflection when the probe is immersed in dense liquids and powders.

Operation

The reflection probe consists of a 6-fiber leg (the illumination leg) that should be coupled to the light source, and a single-fiber leg (the read leg) that attaches to the spectrometer.

1. Inspect the ends of the fiber legs. The hole in the SMA connector is noticeably larger in the illumination leg than the hole in the read leg. Also, the read leg should have colored bands.
2. Attach the illumination leg to the light source.
3. Attach the read leg to the spectrometer.
4. Using the RPH-1 Reflection Probe Holder or some other holding device, point the probe at the surface to be measured.
5. The distance from the probe tip to the sample directly affects the signal. For quantitative results, the distance and angle must be held constant.

Specifications

Fiber core diameter:	200 µm or 400 µm
Fiber core/cladding:	silica
Fiber bundle:	6 illumination fibers around 1 read fiber
Numerical aperture:	0.22
Optimization:	UV/VIS (200-750 nm) and VIS/NIR (450-1000 nm)
Ferrule:	Stainless steel or plastic
Ferrule dimensions:	3.0" x 0.25"
Terminations:	SMA 905
Sheathing:	Blue PVC with Kevlar reinforcement
Temperature range:	-20° C to 80° C
Probe assembly length:	2 meters (breakout is halfway); custom probes are also available

RPH-1 Reflection Probe Holder

The **RPH-1 Reflection Probe Holder** is an anodized aluminum platform with machined holes at 45° and 90° to hold our R200 Reflection Probes or other 0.25" O.D. probes during reflection measurements. Common applications include measuring the reflection properties of mirrors and anti-reflection coatings, and measuring the visual properties of color in paints, graphic arts, plastic, and food products.

Operation

Reflection is the return of radiation by a surface, without a change in wavelength. The reflection may be:

- Specular, in which the angle of incidence is equal to the angel of reflection. If taking specular reflection measurements, position the reflection probe in the 90° aperture of the RPH-1.
- Diffuse, in which the angle of incidence is not equal to the angle of reflection. If taking diffuse reflection measurements, position the reflection probe in the 45° aperture of the RPH-1.

Every surface returns both specular and diffuse reflections. Some surfaces may return mostly specular reflection, others more diffuse reflection. The glossier the surface, the more specular the reflection.

Specular Reflectance Measurements

For a specular reflection measurement, attach the illumination leg of your reflection probe to a light source, and the read leg to the spectrometer. Place the end of the probe in the 90° aperture of the RPH-1. Use the cap screw on the holder to secure the probe at the desired distance from the sample.

1. First, take a reference spectrum. Make sure nothing is blocking the light path going to your reference. Place the reflection probe/probe holder over a first-surface mirror. Take the reference reading.
2. Next, take a dark spectrum. Completely block the light path going to your sample. Do not turn off the light source. Take the dark reading.
3. Finally, take your reflection measurement. Make sure the sample is in place and nothing is blocking the light going to your sample. If using OOIBase32, click on the **Transmission** icon to take your spectrum. (The Transmission Mode uses the same formula for transmission and reflection measurements.)

Diffuse Reflectance Measurements

For a diffuse reflection measurement, attach the illumination leg of your reflection probe to a light source, and the read leg to the spectrometer. Place the end of the probe in the 45° aperture of the RPH-1. Use the cap screws on the holder to secure the probe at the desired distance from the sample.

1. First, take a reference spectrum. Make sure nothing is blocking the light path going to your reference. Place the reflection probe/probe holder over a diffuse standard. Take the reference reading.
2. Next, take a dark spectrum. Completely block the light path going to your sample. Do not turn off the light source. Take the dark reading.
3. Finally, take your reflection measurement. Make sure the sample is in place and nothing is blocking the light going to your sample. If using OOIBase32, click on the **Transmission** icon to take your spectrum. (The Transmission Mode uses the same formula for transmission and reflection measurements.)

T300-RT-UV-VIS Transmission Dip Probe

The **T300-RT-UV/VIS Transmission Dip Probe** couples to our spectrometers and light sources to create small-footprint optical-sensing systems for measuring *in situ* transmission in chemical solutions and other liquids. The standard T300-RT-UV/VIS Transmission Dip Probe has (2) 300 µm diameter solarization-resistant fibers (1 illumination, 1 read), in a 5.0" x 0.25" OD stainless steel ferrule. Screw-on, interchangeable probe tips, in path lengths of 2 mm, 5 mm or 10 mm, are available to configure your system for either optically dense or dilute solutions.

Caution!

- Handle with care. Dropping the instrument may cause permanent damage.
- Bubbles will interfere with your readings. Regularly inspect the sample region for bubbles.

Operation

The T300 consists of two identical fibers in a bifurcated assembly. A plano-convex lens shapes the light coming out of the illumination fiber. The light is transmitted through the sample, hits the mirror, reflects off the mirror, and interacts with the sample again before being transmitted back through the probe via the read fiber. Because the light travels through the sampling region twice, the optical pathlength is actually twice the length of the sample aperture. The transmission cell is used to measure absorbance of the fluid that fills the sample compartment between the fibers and the mirror, which is a UV-enhanced aluminum, second-surface mirror.

1. Connect one leg of the probe to the light source and connect the other leg to the spectrometer. It does not matter which leg of the probe is connected to the light source or spectrometer.
2. Make sure the probe tip you want to use for your experiment is screwed onto the end of the probe. To replace the probe tip, simply unscrew the probe tip and screw in either the 2 mm, 5 mm or 10 mm replaceable tip.
3. Prepare your sample.
4. While the probe tip is in the sample, you should achieve a signal in Scope Mode (for OOIBase32 software) of ~3500 counts. To achieve the best signal, use an Allen wrench to loosen the set screw on the inner fiber barrel assembly and slide it up and down to change the intensity of the light returned. (The inner barrel is set at the time of manufacture for a 10 mm tip in aqueous media. If your application requires measuring gases you will have to adjust the inner barrel.) You may also have to adjust the integration time to achieve this signal.
5. Immerse the probe in distilled water or the solvent of your choice and take a reference spectra.
6. Remove the probe from the reference, block the light path going to the spectrometer and take a dark spectrum.
7. Make sure the light path is clear, place the probe in your sample solution and take your sample spectra.

Specifications

Fiber core diameter:	300 µm
Fiber material	silica (core/cladding), aluminum (jacketing)
Fiber bundle:	1 illumination fiber and 1 read fiber (solarization-resistant)
Fiber bundle length:	2 meters (breakout is 1.5 meters from probe tip)
Wavelength optimization:	200-1100 nm
Numerical aperture:	0.22
Inner and outer ferrules:	Stainless steel
Ferrule diameters:	0.125" (inner ferrule diameter), 0.25” (outer ferrule diameter)
Outer ferrule length:	5.0"
Terminations for illumination and read legs:	SMA 905
Path lengths:	2 mm, 5 mm and 10 mm stainless steel removable tips
Temperature tolerance of epoxy:	to 400° C

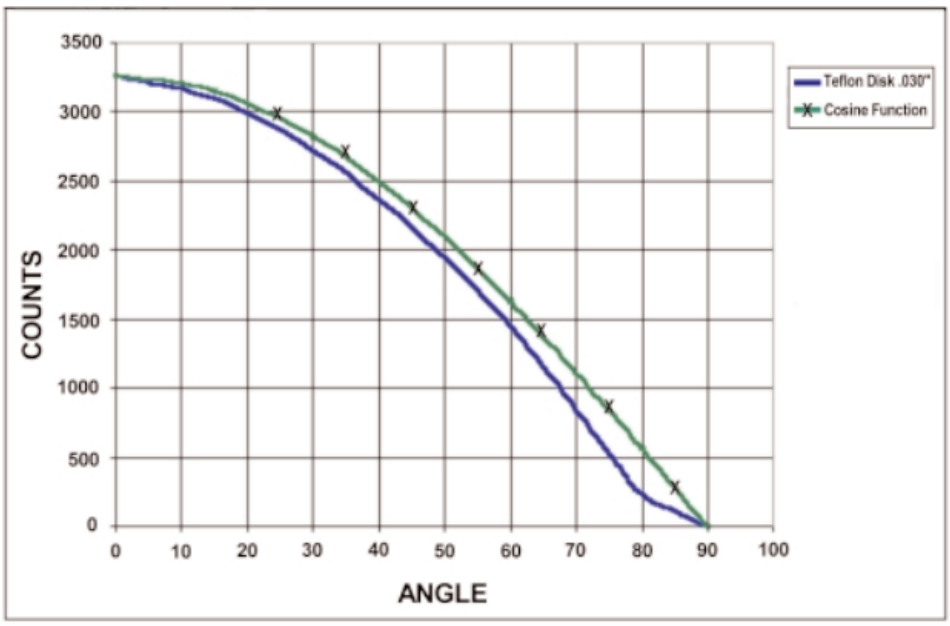
CC-3 Cosine-corrected Irradiance Probes

The **CC-3 Cosine-corrected Irradiance Probes** are spectroradiometric sampling optics designed to collect radiation (light) from a 180° field of view, thus eliminating light collection interface problems inherent to other sampling devices. The **CC-3 Cosine-corrector** (300-1000 nm) has glass diffusing material. The **CC-3-UV Cosine-corrector** (200 nm to 2 µm) has Teflon® diffusing material. The diffusing material is a thin disk that sits at the end of the barrel (the Teflon material is 0.30" thick). Both cosine correctors have a 0.25" OD barrel with a smooth yet rugged black oxide finish.

Operation

Both cosine correctors have SMA 905 connectors for convenient coupling to optical fibers. Screw the CC-3 or CC-3-UV onto the end of any SMA-terminated optical fiber, and the combination becomes a cosine-corrected irradiance probe. When coupled to a spectrometer, these irradiance probes can be used to measure UV-A and UV-B solar radiation, environmental light fields, lamps and other emission sources.

CC-3-UV Cosine Corrector -- Function Test



Specifications

Diffusing material:	Opaline glass or Teflon
Barrel dimension:	0.25" OD
Sampling geometry:	accepts light at/from 180° FOV
Connector:	SMA 905

FL-400 Flame-resistant Fiber Probe

The **FL-400 Flame-resistant Fiber Probe** is a heat-resistant fiber optic probe that couples to Ocean Optics miniature fiber optic spectrometers to measure *in situ* emission spectra of samples such as dissolved metals and high-temperature plasmas. The FL-400 is a high-temperature 400-µm gold-jacketed UV-VIS optical fiber in an 8" long nickel sleeve. It can operate in environments up to 750º C. The probe comes with a standard wire loop for emission measurements of dissolved metals. Not included, though necessary for operation, is an optical fiber and a splice bushing for connecting the FL-400 to the optical fiber.

Operation

1. Twist the male end of the FL-400 into a 21-02 Splice Bushing.
2. Connect a standard optical fiber (normally a P400-2-UV/VIS 400 µm optical fiber) to the other end of the splice bushing.
3. To observe flame emission spectra of samples such as sodium, potassium, calcium and copper attach the wire loop to the FL-400 by slipping the FL400 into the coil spring of the wire loop.

Specifications

Fiber core diameter:	400 µm
Fiber core/cladding:	Silica
Fiber core/cladding diameter:	440 µm
Fiber jacketing:	Gold
Fiber core/cladding/jacketing diameter:	510 µm
Fiber bundle:	1 single-strand, multi-mode read fiber
Wavelengths covered:	200-750 nm
Probe sleeve (ferrule):	Nickel
Probe sleeve (ferrule) length:	~8.0" or 20 cm
Temperature range:	-269º C to 750º C
Numerical aperture:	0.22
Fiber termination:	SMA 905

Optical Fiber Assemblies

Ocean Optics offers an extensive line of optical fibers and accessories -- including patch cords, bifurcated assemblies, bushings, and splitters -- for a variety of UV-VIS and VIS-NIR applications. All optical fibers couple easily via SMA terminations to our miniature fiber optic spectrometers, light sources and sampling optics. Ocean Optics optical fibers offer great flexibility, both in the literal sense (by transporting light around corners, for example) and in the way fiber-based systems are constructed (by linking light sources and sampling optics, for example, to create an optical interface to the spectrometer). Optical fibers allow the user to easily convert the optical interface from one setup to another -- absorbance, reflectance and emission are the three basic options -- to create an almost endless variety of optical-sensing systems.

These silica-core and silica-clad optical fibers are optimized for the UV-VIS (200-750 nm) or VIS-NIR (450-1000 nm). Standard assemblies are 2 meters in length, and are available in sizes ranging from 8 µm to 1000 µm in diameter. Custom options include optical fibers with solarization-resistance properties (for applications <250 nm), and in lengths other than 2 meters.

Caution!

- Gently remove the plastic cover from the SMA connector before use. Pulling the SMA connector away from the fiber when removing the plastic cover will permanently damage the fiber.
- When fibers break, they stop transmitting light. Be sure to inspect fibers by eye to determine if light is being transmitted.
- Do not coil the fiber too tightly. The maximum sustained bend radius of a 400 µm fiber is 10 cm. Bending the fiber will cause attenuation. To minimize this effect, add extra strain relief to both ends of the fiber.
- Do not exceed the temperature specifications for the materials involved: 200°C for the fiber, 100°C for PVC cabling, 100°C for standard epoxy.
- Do not allow the fiber to be bent at a sharp angle. A bending radius of less than one inch is dangerous.
- Keep connectors and probe tips covered when the fibers are not being used.
- Clean ends of the fibers with lens paper and distilled water, alcohol, or acetone. Avoid scratching the surface.
- Do not immerse fiber ends in caustic materials or other solutions that can damage quartz or aluminum.

Operation

Patch Cords

Patch cords are single strands of optical fiber. The active part consists of a silica core, surrounded by a silica cladding material. The fiber is very fragile, and if not protected by a suitable buffer material, would be nearly useless for most applications. The buffer materials are polymer coatings that provide mechanical strength, either polyamide or Teflon. Cabling further protects the buffer-coated fiber. Our standard laboratory cabling is blue PVC. Other cabling that is available includes stainless steel monocoil. The ends of the fibers are cleaved, epoxied into the connectors, and polished.

Bifurcated Assemblies and Splitters

Bifurcated assemblies and splitters allow you to route light from 1 location to 2 locations, or to collect light from 2 locations and combine the output into 1 location. The assemblies are shaped like a “Y” with a stainless steel breakout located midway from the ends of the fibers. The common end of bifurcated assemblies has 2 fibers laying side by side. The spatial difference between the two fibers may be important in your application. If this difference matters, then a splitter is required. The common end of a bifurcated fiber can be coupled to a larger diameter single fiber with a splice bushing to create a functional splitter.

Splice Bushings, Bulkhead Fittings

Splice bushings are used to couple two SMA-terminated fibers together. Simply screw each fiber into the splice bushing finger-tight. Bulkhead fittings are used to fixture a fiber onto a panel. Install the bulkhead by drilling a hole in the wall where you wish to mount the fiber. Fasten with the lock washer and nut provided.

Solarization-resistant Fibers

If you are using a UV light source, the UV radiation degrades the silica in a standard patch cord over time, resulting in increased absorption and invalid data. The degradation is called solarization. The active part of our solarization-resistant fibers consists of a silica core, surrounded by a silica cladding material. Then the fiber is coated in aluminum, which prevents the fiber from solarizing.

Optical Fiber Color Codes

All Ocean Optics optical fibers are color-coded for simple identification. There are two color bands on one end of the fiber. The color band nearest the termination identifies the fiber type (i.e., its wavelength optimization), and is either white (UV/VIS) or black (VIS/NIR). The second color band identifies the diameter of the fiber, and is one of several different colors. Use the table below as a handy reference.

Band Color	Core Diameter (µm)
Purple	8 (VIS/NIR only)
Blue	50
Green	100
Yellow	200
Gray*	300
Red	400
Brown	600
Clear	1000

Band Color	Fiber Type
White	UV/VIS
Black	VIS/NIR

* The 300 µm optical fiber is a solarization-resistant fiber for applications <250 nm.

Specifications

Jacket:	Acrylate (temperature range -40° to 100° C), for 50 µm optical fibers Nylon (temp range -40° to 100° C), for 100, 200, 400, 600 and 1000 µm optical fibers Aluminum (temp range -269° C to 400° C), for 300 µm solarization-resistant fibers
Sheathing/cabling:	PVC with Kevlar reinforcement (standard) PVC Monocoil (optional) BX flexible metal sleeve (optional)
Connector/termination:	SMA 905
Fiber core:	pure fused silica
Cladding:	doped fused silica
Fiber profile:	step-index multi-mode
Operating wavelengths:	UV-VIS (200-750 nm) VIS-NIR (450-1000 nm)
Numerical aperture:	0.22
Recommended minimum bend radius:	momentary = 200x the fiber radius (for standard patch cords) long term = 400x the fiber radius (for standard patch cords)

Experiment Tutorial

Before you begin your experiment, double-check that you have correctly installed your A/D converter, installed the operating software, and set up your light source and other sampling optics. Next:

1. Open OOIBase32. Although you already configured your hardware when you installed your A/D converter, double-check that **A/D Interface** settings correspond to your setup by choosing **Spectrometer | Configure** from the menu.

2. Now check your spectrometer setup configurations in OOIBase32. A Wavelength Calibration Data Sheet and a floppy diskette with the Spectrometer Configuration file on it is shipped with each spectrometer. You will need these calibration coefficients on this sheet. Select **Spectrometer | Configure** from the menu and choose the **Wavelength Calibration** page. For each spectrometer channel in your system, enable the channel and make sure the First Coefficient, Second Coefficient, Third Coefficient and Intercept correspond to those of your system.

3. Adjust your acquisition parameters using the **Acquisition Parameters** dialog bar or select **Spectrum | Configure Data Acquisition** from the menu.

4. Acquiring spectral data from your spectrometer is quite simple. Assuming that you have followed the previous steps and started OOIBase32, your spectrometer is already acquiring data. Even with no light in the spectrometer, you should see a fluctuating trace near the bottom of the graph. If you put light into the spectrometer, you should see the graph trace rise with increasing light intensity. If this occurs, you have correctly installed your hardware and software.

5. Once you installed and configured your hardware and software, and have set up your system, you are ready to take your measurements. There are four basic optical measurements from which to choose: absorbance, transmission, reflection, and relative irradiance measurements. The type of measurements you wish to make determines the configuration of the sampling optics for your system. The choice of reference and data analysis determines how the answer is presented.

6. For each measurement, a reference and dark spectrum must first be made. After taking a reference and a dark spectrum, you may take as many absorbance, transmission, reflection, or relative irradiance measurement scans as you want. However, if at any time any sampling variable changes (integration time, averaging, smoothing, angle, temperature, fiber size, etc.) you *must* store a new dark and reference spectrum.

Application Tips

If the signal you collect is saturating the spectrometer (peaks are off the scale), you can decrease the light level on scale in scope mode by:

- Decreasing the integration time
- Attenuating the light going into the spectrometer
- Switching to a smaller diameter fiber
- Using a neutral density filter with the correct optical density

If the signal you collect has too little light, you can increase the light level on scale in scope mode by:

- Increasing the integration time
- Switching to a larger diameter fiber
- Avoiding the use of any optical filters

Absorbance Experiments

Absorbance spectra are a measure of how much light is absorbed by a sample. For most samples, absorbance is linearly related to the concentration of the substance. The software calculates absorbance ($A\lambda$) using the following equation:

$$A_\lambda = -\log_{10}\left(\frac{S_\lambda - D_\lambda}{R_\lambda - D_\lambda}\right)$$

where S is the sample intensity at wavelength λ, D is the dark intensity at wavelength λ, R is the reference intensity at wavelength λ.

Absorbance can also be expressed as proportional to the concentration of the substance interacting with the light, known as Beer's Law. Common applications include the quantification of chemical concentrations in aqueous or gaseous samples. To take an absorbance measurement using OOIBase32, our spectrometer operating software, follow these steps:

1. Make sure you are in scope mode, by either clicking the scope mode icon on the toolbar, or selecting **Spectrum | Scope Mode** from the menu. Make sure the signal is on scale. The peak intensity of the reference signal should be about 3500 counts.
2. Take a reference spectrum by first making sure nothing is blocking the light path going to your sample. The analyte you want to measure must be absent while taking a reference spectrum. Take the reference reading by clicking the store reference spectrum icon on the toolbar or selecting **Spectrum | Store Reference** from the menu. (This command merely stores a reference spectrum. You must select **File | Save | Reference** from the menu to permanently save the spectrum to disk.) Storing a reference spectrum is requisite before the software can calculate absorbance spectra.
3. While still in scope mode, take a dark spectrum by first completely blocking the light path going to your sample. (If possible, do not turn off the light source. If you must turn off your light source to store a dark spectrum, make sure to allow enough time for the lamp to warm up before continuing your experiment.) Take the dark reading by clicking the store dark spectrum icon on the toolbar or selecting **Spectrum | Store Dark** from the menu. (This command merely stores a dark spectrum. You must select **File | Save | Dark** from the menu to permanently save the spectrum to disk.) Storing a dark spectrum is requisite before the software can calculate absorbance spectra.
4. Begin an absorbance measurement by first making sure the sample is in place and nothing is blocking the light going to your sample. Then choose the absorbance mode icon on the toolbar or select **Spectrum | Absorbance Mode** from the menu. To save the spectrum, click the save icon on the toolbar or select **File | Save | Processed** from the menu.

If at any time any sampling variable changes -- including integration time, averaging, boxcar smoothing, distance from light source to sample, etc. -- you must store a new reference and dark spectrum.

Transmission Experiments

Transmission is the percentage of energy passing through a system relative to the amount that passes through the reference. Transmission Mode is also used to show the portion of light *reflected* from a sample. Transmission and reflection measurements require the same mathematical calculations. The transmission is expressed as a percentage (%Tλ) relative to a standard substance (such as air). The software calculates %T (or %Rλ) by the following equation:

$$\%T_\lambda = \frac{S_\lambda - D_\lambda}{R_\lambda - D_\lambda} \times 100\%$$

where S is the sample intensity at wavelength λ, D is the dark intensity at wavelength λ, R is the reference intensity at wavelength λ.

Common applications include measurement of transmission of light through solutions, optical filters, optical coatings, and other optical elements such as lenses and fibers. To take a transmission measurement using OOIBase32, our spectrometer operating software, follow these steps:

1. Make sure you are in scope mode, by either clicking the scope mode icon on the toolbar, or selecting **Spectrum | Scope Mode** from the menu. Make sure the signal is on scale. The peak intensity of the reference signal should be about 3500 counts.
2. Take a reference spectrum by first making sure nothing is blocking the light path going to your sample. The analyte you want to measure must be absent while taking a reference spectrum. Take the reference reading by clicking the store reference spectrum icon on the toolbar or selecting **Spectrum | Store Reference** from the menu. (This command merely stores a reference spectrum. You must select **File | Save | Reference** from the menu to permanently save the spectrum to disk.) Storing a reference spectrum is requisite before the software can calculate transmission spectra.
3. While still in scope mode, take a dark spectrum by first completely blocking the light path going to your sample. (If possible, do not turn off the light source. If you must turn off your light source to store a dark spectrum, make sure to allow enough time for the lamp to warm up before continuing your experiment.) Take the dark reading by clicking the store dark spectrum icon on the toolbar or selecting **Spectrum | Store Dark** from the menu. (This command merely stores a dark spectrum. You must use the Save Dark command to permanently save the spectrum to disk.) Storing a dark spectrum is requisite before the software can calculate transmission spectra.
4. Begin a transmission measurement by first making sure the sample is in place and nothing is blocking the light going to your sample. Then choose the **transmission mode** icon on the toolbar or select **Spectrum | Transmission Mode** from the menu. To save the spectrum, click the **save** icon on the toolbar or select **File | Save | Processed** from the menu.

If at any time any sampling variable changes -- including integration time, averaging, boxcar smoothing, distance from light source to sample, etc. -- you must store a new reference and dark spectrum.

Reflection Experiments

Reflection is the return of radiation by a surface, without a change in wavelength. The reflection may be:

- Specular, in which the angle of incidence is equal to the angle of reflection.
- Diffuse, in which the angle of incidence is not equal to the angle of reflection.

Every surface returns both specular and diffuse reflections. Some surfaces may return mostly specular reflection, others more diffuse reflection. The glossier the surface, the more specular the reflection. Reflection is expressed as a percentage (%Rλ) relative to the reflection from a standard reference substance:

$$\%R_\lambda = \frac{S_\lambda - D_\lambda}{R_\lambda - D_\lambda} \times 100\%$$

where *S* is the sample intensity at wavelength λ, *D* is the dark intensity at wavelength λ, *R* is the reference intensity at wavelength λ.

Common applications include measuring the reflection properties of mirrors, anti-reflection coatings, and measuring the visual properties of the color in paints, graphic arts, plastics, and food products. To take a reflection measurement using OOIBase32, our spectrometer operating software, follow these steps:

1. Make sure you are in scope mode, by either clicking the scope mode icon on the toolbar, or selecting **Spectrum | Scope Mode** from the menu. Make sure the signal is on scale. The peak intensity of the reference signal should be about 3500 counts. During a reflection measurement, keep the angle and distance from your reference and sample to your collection optics the same.
2. Take a reference spectrum by first making sure nothing is blocking the light path going to your sample. The analyte you want to measure must be absent while taking a reference spectrum. Take the reference reading by clicking the store reference spectrum icon on the toolbar or selecting **Spectrum | Store Reference** from the menu. (This command merely stores a reference spectrum. You must select **File | Save | Reference** from the menu to permanently save the spectrum to disk.) Storing a reference spectrum is requisite before the software can calculate reflection spectra.
3. While still in scope mode, take a dark spectrum by first completely blocking the light path going to your sample. (If possible, do not turn off the light source. If you must turn off your light source to store a dark spectrum, allow enough time for the lamp to warm up before continuing your experiment.) Take the dark reading by clicking the store dark spectrum icon on the toolbar or selecting **Spectrum | Store Dark** from the menu. (This command merely stores a dark spectrum. You must use the Save Dark command to permanently save the spectrum to disk.) Storing a dark spectrum is requisite before the software can calculate reflection spectra.
4. Begin a reflection measurement by first making sure the sample is in place and nothing is blocking the light going to your sample. Then choose the transmission mode icon on the toolbar or select **Spectrum | Transmission Mode** from the menu. The mathematics required to calculate reflection measurements are identical to those necessary to compute a transmission spectrum. To save the spectrum, click the save icon on the toolbar or select **File | Save | Processed** from the menu.

If at any time any sampling variable changes -- including integration time, averaging, smoothing, distance from light source to sample, etc. -- you must store a new reference and dark spectrum.

Relative Irradiance Experiments

Irradiance is the amount of energy at each wavelength from a radiant sample. In relative terms, it is the fraction of energy from the sample compared to the energy collected from a lamp with a blackbody energy distribution, normalized to 1 at the energy maximum. Relative irradiance is calculated by the following equation:

$$I_\lambda = B_\lambda \left(\frac{S_\lambda - D_\lambda}{R_\lambda - D_\lambda} \right)$$

where B is the relative energy of the reference (calculated from the color temperature) at wavelength λ, S is the sample intensity at wavelength λ, D is the dark intensity at wavelength λ, R is the reference intensity at wavelength λ.

Common applications include characterizing the light output of LEDs, incandescent lamps and other radiant energy sources such as sunlight. Also included in relative irradiance measurements is fluorescence, in which case the spectrometer measures the energy given off by materials that have been excited by light at a shorter wavelength. To take a relative irradiance measurement using OOIBase32, our spectrometer operating software, follow these steps:

1. Make sure you are in scope mode, by either clicking the scope mode icon on the toolbar, or selecting **Spectrum | Scope Mode** from the menu. Make sure the signal is on scale. The peak intensity of the reference signal should be about 3500 counts. The light source must be a blackbody of known color temperature.
2. Take the reference reading by clicking the store reference spectrum icon on the toolbar or selecting **Spectrum | Store Reference** from the menu. (This command merely stores a reference spectrum. You must use the Save Reference command to permanently save the spectrum to disk.) Storing a reference spectrum is requisite before the software can calculate relative irradiance spectra.
3. While still in scope mode, take a dark spectrum by completely blocking the light path. (If possible, do not turn off the light source.) Take the dark reading by clicking the store dark spectrum icon on the toolbar or selecting **Spectrum | Store Dark** from the menu. (This command merely stores a dark spectrum. You must use the Save Dark command to permanently save the spectrum to disk.) Storing a dark spectrum is requisite before the software can calculate relative irradiance spectra.
4. Take a relative irradiance measurement by first positioning the fiber at the light source you wish to measure. Then choose the irradiance mode icon on the toolbar or select **Spectrum | Relative Irradiance Mode** from the menu. In the **Reference Color Temperature** dialog box, enter the light source's color temperature in Kelvin and click **OK**. To save the spectrum, click the save icon on the toolbar or select **File | Save | Processed** from the menu.

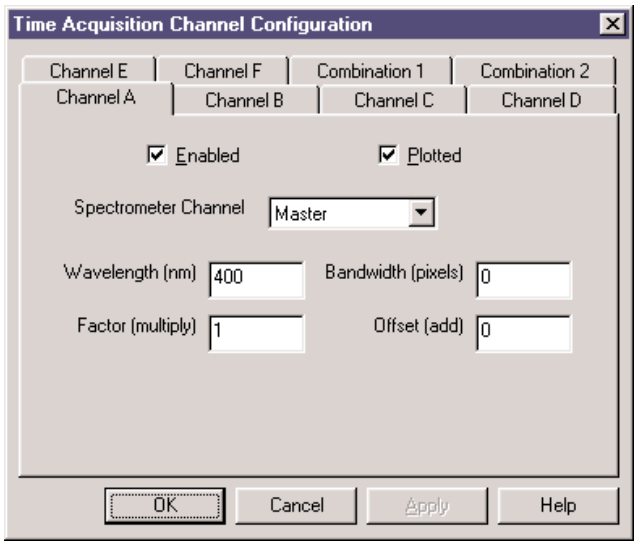
If at any time any sampling variable changes -- including integration time, averaging, boxcar smoothing, distance from light source to sample, etc. -- you must store a new reference and dark spectrum.

Time Acquisition Experiments

Our OOIBase32 Spectrometer Operating Software allows you to perform time acquisition experiments. Time acquisition experiments track processes, perform kinetic analyses, and monitor spectral events as a function of time. You can collect as a function of time spectral data from up to 6 single wavelengths (designated as Channels A through F) and up to two mathematical combinations of these wavelengths (designated as Combinations 1 and 2). You can acquire data in any mode. (For more details about this and other OOIBase32 functions, refer to the **OOIBase32 Spectrometer Operating Software Manual**.) To perform a time series experiment in OOIBase32, follow these steps:

1. While in scope mode, store reference and dark spectra, if desired, and choose a view mode, such as absorbance.

2. Access the Time Acquisition Channel Configuration dialog box by selecting **Time Acquisition | Configure | Configure Time Channels** from the menu.
   - Select **Enabled** to set the time acquisition calculation for the wavelength. Without selecting Enabled, the time acquisition process will not calculate data.
   - Enable **Plotted** to see a real time graph of the acquired data in a spectral window.
   - Select a **Spectrometer Channel** for your time acquisition process.
   - In the **Wavelength (nm)** box, specify the analysis wavelength. In the **Bandwidth (pixels)** box, specify the number of pixels averaged around the analysis wavelength.
   - Select a multiplicative **Factor** to apply to the data before it is plotted or stored. Select an additive constant or **Offset** to apply to the data after the factor is applied and before the data is plotted or stored. The equation for the Factor and Offset functions is: Results = (Factor x Data) + Offset.



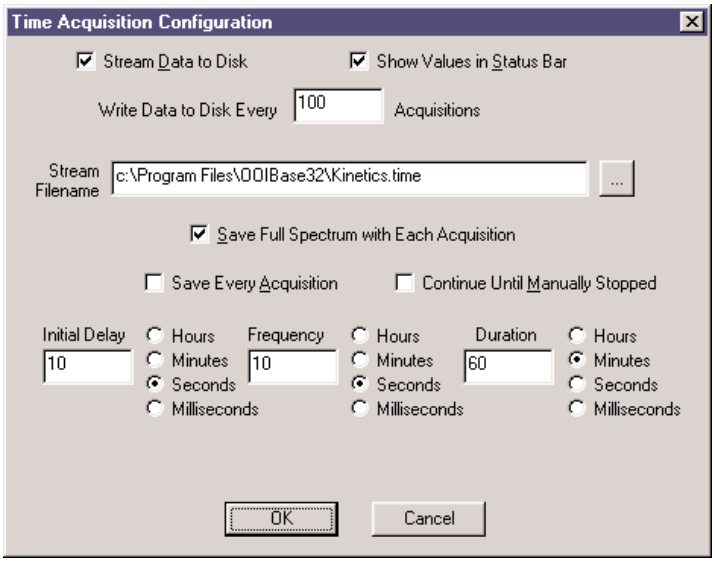
3. If desired, configure a time acquisition process for the second single wavelength by selecting the **Channel B** page. To configure a time acquisition process for the third, fourth, fifth, and sixth single wavelengths, select the **Channel C**, **Channel D**, **Channel E**, and **Channel F** pages, respectively, and set the necessary parameters.

4. If desired, configure a time acquisition process for a combination of two time channels by selecting **Combination 1**.
   - Select **Enabled** to set the time acquisition calculation for the wavelength.
   - Enable **Plotted** to see a real time graph of the acquired data in a spectral window.
   - Specify Time Channel A through F for the **First Channel**.
   - Select the mathematical **Operation** to produce the data for Combination 1.
   - Specify Time Channel A through F for the **Second Channel**.
   - Select a multiplicative **Factor** to apply to the data before it is plotted or stored. Select an additive constant or **Offset** to apply to the data after the factor is applied and before the data is plotted or stored. The equation for the Factor and Offset functions is: Results = (Factor x Data) + Offset.

5. If desired, configure a time acquisition process for the **Combination 2** page. It is almost identical to the Combination 1 page except that you have the option of choosing Combination 1 for your **First Channel** or **Second Channel**.

6. Click the OK button for the Time Acquisition Channel Configuration dialog box.

7. Access the Time Acquisition Configuration dialog box by selecting **Time Acquisition | Configure | Configure Acquisition** from the menu.
   - Enable **Stream Data to Disk** to save time acquisition data.
   - Enter a value in the **Write Data to Disk Every X Acquisitions** box to set the frequency for saving data. The smaller this number, the more frequently data is saved. The larger this number, the less frequently data is saved; but entering a large number enhances the performance of the time acquisition process.



At specified time intervals, data from OOIBase32 is stored into time acquisition channels or combination channels. This data can be simply plotted in a spectral window, or streamed to disk, or both. Up to 2048 acquisitions can be displayed in a spectral window. If more than 2048 acquisitions are gathered, only the last 2048 of them will be displayed. To store more than 2048 acquisitions, you must stream the data to disk. Writing data to the disk is a slow process (relative to the speed of some spectral acquisitions) and causes a decrease in system performance. However, writing data to disk more frequently gives a larger margin of safety.

- Enable **Show Values in Status Bar** to see the time acquisition values in the status bar. These values replace the cursor values.
- Name the **Stream Filename** for the time acquisition process. Clicking on the ellipsis to the right of this box opens a file save dialog box allowing you to navigate to a designated folder.
- Enable **Save Every Acquisition** to store data for every spectral acquisition during a time acquisition process.

There are options to either store data for each acquisition, or to collect data only after a specified delay. Several factors affect the minimum time acquisition frequency, including integration time, number of spectrometer channels, samples averaged, and computer speed. If you specify that you want data to be stored every 100 milliseconds, it is guaranteed that the delay will be *at least* 100 milliseconds, but could be much longer depending on your experimental configuration. OOIBase32 spends a large amount of time calculating, rendering and displaying the spectra in a spectral window. You have the option to suspend graph display, which greatly improves performance.

- Enable **Continue Until Manually Stopped** to store data until you manually stop the acquisition process by clicking on the stop icon or selecting **Time Acquisition | Stop**.
- Enter an **Initial Delay** to set the delay before the time acquisition process begins. However, the delay countdown cannot begin until you initiate the time acquisition process by clicking on the start icon or selecting **Time Acquisition | Start** from the menu. Be sure to select **Hours**, **Minutes**, **Seconds** or **Milliseconds** immediately to the right of the initial delay entry.
- Enter a value to set the **Frequency** of the data collected in a time acquisition process. Data from a time acquisition is stamped with a time that is accurate to 1 millisecond. Be sure to select **Hours**, **Minutes**, **Seconds** or **Milliseconds** immediately to the right of the frequency entry.
- Enter a value to set the **Duration** for the entire time acquisition process. Be sure to select **Hours**, **Minutes**, **Seconds** or **Milliseconds** to the right of the duration entry.

8. Click the OK button for the Time Acquisition Configuration dialog box.

9. Initiate the Time Acquisition mode by either clicking on the alarm clock icon in the Time Acquisition toolbar or selecting **Time Acquisition | Activate Time Acquisition** from the OOIBase32 menu. You can then start a time acquisition process by selecting the start icon or by selecting **Time Acquisition | Start** from the menu.

Appendix A: Calibrating the Wavelength of the Spectrometer

The following 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.

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

$$\lambda_p = I + C_1 p + C_2 p^2 + C_3 p^3$$

. . . where λ is the wavelength of pixel p, I is the wavelength of pixel 0, C_1 is the first coefficient (nm/pixel), C_2 is the second coefficient (nm/pixel^2), and C_3 is the third coefficient (nm/pixel^3). You will be calculating the value for I and the three Cs.

Setting Up

To re-calibrate the wavelength of your spectrometer, you will need the following:

- A light source that produces spectral lines. Ocean Optics' HG-1 Mercury-Argon lamp is ideal for this purpose. If you do not have an HG-1, you will need a spectral line source that produces several (at least 4-6) spectral lines in the wavelength region of your spectrometer.
- Your spectrometer.
- An optical fiber (for spectrometers without a built-in slit, a 50-µm fiber works best).
- Either a spreadsheet program (Excel or Quattro Pro, for example) or a calculator that performs third-order linear regressions. If you are using Microsoft Excel, choose **Tools | Add-Ins** and check **AnalysisToolPak** and **AnalysisToolPak-VBA**.

Calibrating the Wavelength of your Spectrometer

1. After placing OOIBase32 into Scope Mode, 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 carefully position it so that it is at the point of maximum intensity. Record the pixel number that is displayed in the status bar (located beneath the graph). Repeat this step for all of the peaks in your spectrum.
3. Using your spreadsheet, create a table like the one shown on the next page. In the first column, place the exact or true wavelength of the spectral lines that you used. Most calibration line sources come with a wavelength calibration sheet. If you do not have a wavelength calibration sheet for your light source, you can probably find the wavelengths for your spectral lines (assuming that they are being produced by pure elements) in a Chemistry or Physics textbook or handbook, such as the *CRC Handbook of Chemistry and Physics*. 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 # ^{2}	Pixel # ^{3}	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

4. Now you are ready to calculate the wavelength calibration coefficients.In your spreadsheet program, find the functions to perform linear regressions.
   -- if using Quattro Pro, look under **Tools | Advanced Math**
   -- if using Excel, look under **Tools | Data Analysis**
5. 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 you execute the regression, an output similar to the one shown below is obtained.

Regression Statistics	
Multiple R	0.999999831
R Square	0.999999663
Adjusted R Square	0.999999607
Standard Error	0.125540214
Observations	22

intercept

	Coefficents	Standard Error
Intercept	190.473993	0.369047536
X Variable 1	0.36263983	0.001684745
X Variable 2	-1.174416E-05	8.35279E-07
X Variable 3	-2.523787E-09	2.656608E-10

first coefficient

second coefficient

third coefficient

6. The numbers of importance are indicated in the above figure. You will need to record the Intercept as well as the First, Second, and Third Coefficients. Also, look at the value for R squared. It should be *very* close to 1. If it is not, you have probably assigned one of your wavelengths incorrectly.
7. Select **Spectrometer | Configure** from the menu and choose the **Wavelength Calibration** page to update the wavelength coefficients within OOIBase32.
8. Repeat this process for each channel in your setup.

Appendix B: Adjusting the Focus for Collimating Lenses

In order to obtain accurate data, the light entering and exiting a sample by means of a fiber/collimating lens assembly must be well collimated. The following is a description of how to adjust the focus of light so that accurate data is collected by the spectrometer. (All collimating lenses are already adjusted at the time of manufacture such that light emerging from a 200 µm fiber/collimating lens assembly is collimated.)

Adjust the focus of the collimating lens on your light source.

1. Connect the fiber that you are going to use as the illumination fiber in your setup to the light source. Ensure the connection is tight. The female SMA connector of the fiber must be screwed all the way into the male connector of the lamp.
2. Turn on the lamp and inspect the light beam emitted from the other end of the fiber by pointing the fiber at a light-colored object such as a white piece of paper. The distance is not too critical but should be at least 3 inches from the surface. Loosen the set screw on the fiber barrel of the light source with an Allen wrench.
3. After the set screw has been loosened, slide the inner barrel of the collimating lens on the light source until you see an even intensity across the beam spot. The spot of light should be uniform; there should be no fluctuations in intensity and color. There should not be any dimmer rings of light surrounding the center spot.
4. Once the inner barrel is positioned so that a well-focused, uniform spot of light is obtained, tighten the set screw with the Allen wrench. Do not put down the fiber and then tighten the set screw. Try to continue to hold the fiber 3 inches from the surface while you tighten so that if the inner barrel of the collimating lens slips and distorts the spot of light, you will be able to readjust the focus. Now the collimating lens on the light source is focused for the fiber.

Adjust the focus of the next collimating lens in your setup.

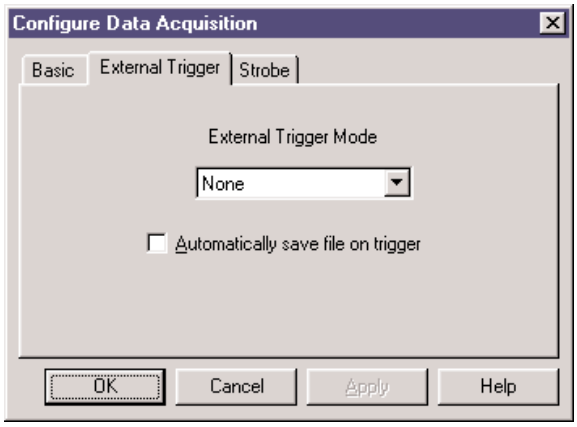
5. For this part of the procedure, the illumination fiber is still connected to the lamp and its collimating lens and the lamp is still on. Now take the second collimating lens in your setup (removed from the illumination side of a cuvette holder, for example) and screw it onto the *other* end of the illumination fiber. Make sure the fiber and the second collimating lens are completely connected. Point this end of the fiber at least 2 meters away from a wall. If the beam spot on the wall is too faint, you may need to dim the room lights.
6. Loosen the set screw that holds the barrel of this second collimating lens in place and slide the barrel until the spot of light focused on the wall has crisp edges. You are looking for the sharpest and cleanest image possible. Tighten the set screw. Do not put the fiber down and then tighten the set screw. Try to continue to hold the fiber with the spot of light focused on the wall while you tighten the set screw so that if the inner barrel of the collimating lens slips and distorts the image while tightening, you will be able to readjust the focus. Now that the second collimating lens has been refocused, remove it from the end of the fiber and install it back into your setup (back into a cuvette holder, for example).

Continue to adjust the focus of the other collimating lenses in your setup.

7. You have completed adjusting the focus of the collimating lenses in the illumination part of your setup. Continue to adjust the focus of the other collimating lenses in your setup. If the read fiber is the same diameter size as the illumination fiber, repeat step 6 with each collimating lens in your setup. If the read fiber is a different diameter size than that of the illumination fiber, you need to remove the illumination fiber from the light source, connect the read fiber to the light source, and repeat step 6 for every collimating lens on the read part of your setup.

Appendix C: External Triggering

Our USB2000 Spectrometers, when used with OOIBase32 Spectrometer Operating Software, provide three methods of acquiring data. In the Normal Mode, Ocean Optics spectrometers are "free running." That is, the spectrometer is continuously scanning, acquiring, and transferring data to your computer, according to parameters set in the software. In this mode, however, there is no way to synchronize the scanning, acquiring and transferring of data with an external event.



To synchronize data acquisition with external events, two other modes of acquiring data are available. Each mode involves connecting an external triggering device to the spectrometer and then applying an external trigger to the spectrometer before the software receives the data. The length of the integration time and the source for the integration clock depend upon the mode chosen. All other acquisition parameters are set in the software. (These external triggering directions are for use with OOIBase32.)

In order for you to use one of the External Triggering options, it is imperative that you know the specifications, limitations and operating functions of your triggering device. The design of your triggering device may prevent you from using one of the external triggering modes as it is described in these pages.

NOTE: To operate in the Software or Hardware Trigger Mode, the triggering device must be connected to Pin 7 of the Accessory Connector. The maximum recommended voltage on Pin 7 is 5.5 V. If your triggering device could exceed this voltage, you must regulate or condition the signal (via transistor buffering, transformer isolation or opto-isolation, for example).

10	8	6	4	2
9	7	5	3	1

Diagram of Pins on the Accessory Connector

External Software Trigger

In this level-triggered mode, the spectrometer is "free running," just as it is in the Normal Mode. The spectrometer is continually scanning and collecting data. With each trigger, the data collected up to the trigger event is transferred to the software. If you continuously apply triggers, such as by holding down the button on an external switch, this mode is equivalent to operating in the Normal Mode.

In the Software Mode, you set the integration time in the software. (It is the only external triggering mode where the integration time is set in the software.) All other acquisition parameters are set in the software as well. The source for the integration clock comes from the A/D converter on the USB2000.

Use the Software Mode if you:

- are using a continuous illumination source, and the light intensity is constant before, during and after the trigger
- need to set the integration time in the software

To Use the Software Mode:

1. Supply a line from Pin 7 of the Connector to your triggering device. (See figure above for pin location.)
2. Set your acquisition parameters in the software via the Acquisition Dialog Bar or the Configure Data Acquisition dialog box. To access the dialog box, click the Data Acquisition icon or select **Spectrum | Configure Data Acquisition** from the menu.

3. Select **Spectrum | Configure Data Acquisition** from the menu. Choose the **External Trigger** page and select **Software Trigger**.
4. To save processed data with each external trigger, enable the **Automatically save file on trigger** box. If you enable this function, you will be presented with a file save dialog box *with each trigger*. To avoid manually naming a file for each trigger, you can enable the **Autoincrement Filenames** function by selecting **File | Autoincrement Filenames | Enabled** from the menu. Choose a base name and starting index for the autoincremented files.
5. Once you select an external trigger mode, it will appear on your computer that your spectrometer is unresponsive. Instead, it is waiting for the trigger. Activate your triggering device. The acquisition parameters, the name of the window acquiring data and the trigger mode are all displayed in the main status bar.

It is important to note that since this is a level-triggered mode, the amount of delay between the trigger pulse and when a spectrum is acquired is indeterminate because the delay is dependent upon the amount of time until the start of the next integration period

External Hardware Trigger

In this edge-triggered mode, the spectrometer is idle until you apply a trigger to the spectrometer. With each trigger, the following occurs:
1. the spectrometer is cleared and then begins integrating
2. the spectrometer integrates for a fixed period of time, the only option being 50 milliseconds
3. the data is transferred to the software, the spectrometer then sits idle waiting for the next trigger

Use the Hardware Mode if you:

- are using a pulsed excitation or light source in your experiment
- are doing LIF (fluorescence with pulsed excitation) or phosphorescence experiments
- need to synchronize an acquisition with an external event

To Use the Hardware Mode:

1. Supply a line from Pin 7 of the Connector to your triggering device. (See figure on page 77 for pin location.)
2. Set acquisition parameters, other than the integration time, such as averaging and boxcar smoothing in the software via the Acquisition Dialog Bar or the Configure Data Acquisition dialog box. To access the dialog box, click the Data Acquisition icon or select **Spectrum | Configure Data Acquisition** from the menu.
3. Select **Spectrum | Configure Data Acquisition** from the menu. Choose the **External Trigger** page and select **Hardware Trigger**.
4. To save processed data with each external trigger, enable the **Automatically save file on trigger** box. If you enable this function, you will be presented with a file save dialog box *with each trigger*. To avoid manually naming a file for each trigger, you can enable the **Autoincrement Filenames** function by selecting **File | Autoincrement Filenames | Enabled** from the menu. Choose a base name and starting index for the autoincremented files.
5. Once you select an external trigger mode, it will appear on your computer that your spectrometer is unresponsive. Instead, it is waiting for the trigger. Activate your triggering device. The acquisition parameters, name of the window acquiring data and trigger mode are displayed in the main status bar.