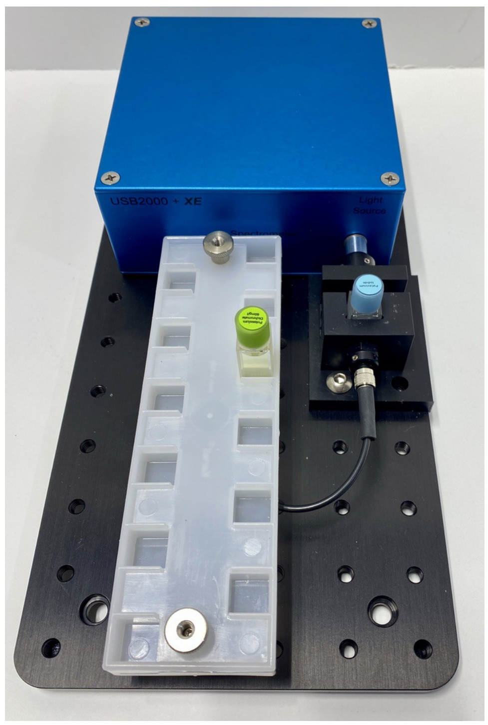
USB2000+XE
USB2000+XE-CUV

USER MANUAL



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Introduction

The White Bear Photonics USB2000+XE and USB2000+XE-CUV models are integrated Xenon Light source with a Ocean Insight USB2000+ UV-VIS CCD spectrometer. This compact integrated system allows one to use a pulsed Xe source for general UV-VIS applications such as transmission, absorbance, and reflectance measurements. Since these types of measurements are highly diverse the goal of this system is to keep the setup simple, compact, and less cluttered. This USB2000+XE module is intended to be compatible with all Ocean Insight fiber coupled accessories, including reflecting probes, cuvette holders, dip probes, flow cells etc. In addition the system is designed to be flexible enough for custom applications such as process monitoring or end of line QA/QC.

For background, the Ocean Insight USB2000+ spectrometer is a legendary model well known for its versatility in many OEM applications. This system works well with the Oceanview software or the Labview driver for the Ocean Optics spectrometers. We do not recommend using this system with the Ocean Optics Spectrasuite software (predecessor of Oceanview) since it very awkward in setting up the triggering properly.

Instrument Specifications

Spectrometer

Spectrometer	USB2000+ UV-VIS
Grating:	Holographic blazed at 300 nm
Slit:	25 um
Recommended Wavelength Range:	200-850nm
Detector Type:	Sony 2048-element linear silicon CCD array
A/D converter :	16 bit
Spectral Resolution:	<1.8 nm
Communication:	USB 2.0
Recommended Fiber type:	High OH, for UV applications
Fiber connector:	SMA 905
Spectrometer Fiber NA:	0.22
Recommended Absorbance Range:	0.1-2.0A
Required Ocean Insight Software:	Oceanview
Operating Systems:	Windows 7, 10 64 bit, IOS, and Linux

Light Source

Light Source type:	Xenon flash lamp
Lamp Ave Power:	6W
Lamp Manufacturer:	Excelitas
XenonLamp Model:	RSL-2101-1
Maximum Repetition Rate:	200 Hz
Operating Voltage:	12VDC
Footprint:	5"x5"x2.1" (127x127x33.4mm)
Weight:	1.8 lb (0.8kg)
Typical Lamp lifetime:	5000 hrs

USB2000+XE-CUV Option

Cuvette	Standard 12 x 12 mm (or smaller with spacer).
Z height	15 mm
Fiber	100 um UV-VIS
Collimation Lens	5 mm Fused silica
Foot print	6 x 12 x 2.6 in (152 x 305 x 66 mm)
Weight	2.2 lbs

Safety.

Note on the back of the unit there is a switch that can turn off the lamp (as labeled). We recommend turning the lamp off with the switch at the end of the day or if fibers are disconnected. Even if you quite the application, the lamp may still be ON, since the strobe enable command may still be active. To be safe one should always use UV grade safety glasses when working with any UV light source.

Principle of Operation

For those not familiar with pulsed light sources with CCD spectrometers, the concept is simple where you pulse the xenon light source each time you acquire a trace. This means the frequency (period) of the integration time is exactly (or multiple thereof) of the lamp frequency (period). To accomplish this the spectrometer has a trigger output that is connected to the trigger input of the lamp (see Fig. 1). One feature added to this system is a attenuator set screw. This is useful to fine tune the light level. Recommended Oceanview settings will follow describing the triggering in more detail.

Pulsed Xe light sources are used in most UV-VIS spectrometers today since they have: long lifetimes compared with deuterium-tungsten sources, wide wavelength range, and require no warm up time. This becomes important if your system will be used to check samples periodically. For example, with a xenon lamp based system, you can turn the switch on, acquire your reference and dark scans and immediately take the sample measurements. This also is possible when the computer is setup to "never sleep" with the Oceanview application left open.

As for maintenance/repair, if the Xe source needs to be replaced (unstable or dead) if can be replaced by the user where the part number and manufacturer is listed in the Specifications.

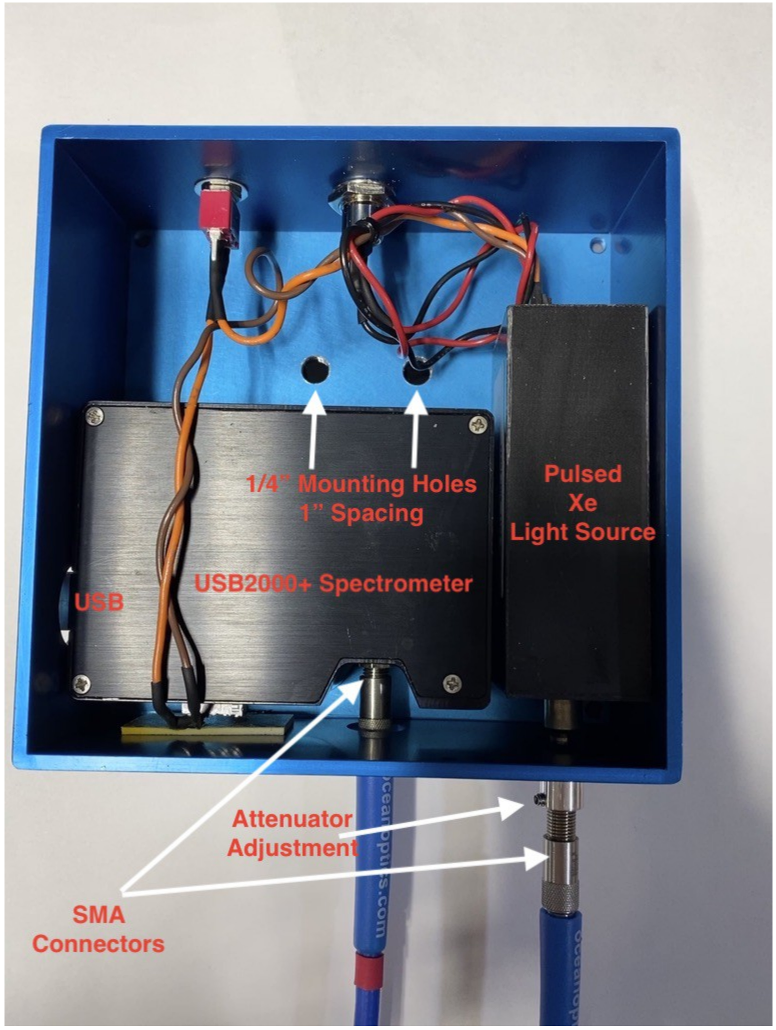

Fig. 1. Layout of the system. Back left switch (brown wires) is to disable the trigger from the spectrometer. This switch is used to disable the lamp which is needed when either taking dark levels or simply turning off the system at the end of the day. The two mounting holes are useful for rigidly mounting the unit on a standard optical bread board (SAE) with 1" hole spacings or on 80-20 extruded aluminum fixtures.

Setup and Operation.

The overall set up in terms of hardware is minimal, since there are only two connections the USB cable and the external 12VDC power supply. Most of the setup involves understanding the software settings in Oceanview.

If you do not have a copy Oceanview we recommend you purchase a copy. This software is supported by OI and if you decide to write your software can serve as a cross check for functionality. Once you download the copy on to your computer, you will then need to activate it with the product key provided by Ocean Insight. You can use the Oceanview-lite version (unlicensed), but you very limited capabilities such as saving your setup parameters. Saving the setup file in the long run, reduces setup time and/or operator error each time you open the application.

Most applications with this system configuration will be Absorbance, Transmission, or Reflectance. The following equations show how each of these are calculated once you have stored the reference and dark values.

$$R\%, T\% = (Is-Id)/(Ir-Id) * 100$$

$$A = \log_{10}[(Is-Id)/(Ir-Id)] * -1$$

Where Is is the signal intensity, Id is the dark counts (lamp is off), Ir is the reference intensity with the sample removed (transmission) or with reflectance standard in place. When we take these measurements, Ir and Id are static or remain constant since they are stored in a buffer. So the variability in the traces (Is) are result mainly the stability of the light source and/or the raw counts.

The USB2000+ spectrometer has a 16bit A/D converter so the range of counts is 2^16 or 65536 counts. During the setup you will see the raw counts in the Y axis range from roughly 0-65,000 counts. After your run through the setup wizards (for Reflectance, Transmission, or Absorbance) the raw counts will be converted to the units (A, %T, and %R) based on the equations above in the measurement window.

For simplicity, we will explain the Oceanview setup in detail using the USB2000+XE-CUV option with Starna standards using the Absorbance setup Wizard. Start by opening the Oceanview application after it has been activated. If the set up wizard does not come up automatically, click on the Oceanview "wave" icon and select the absorbance wizard.

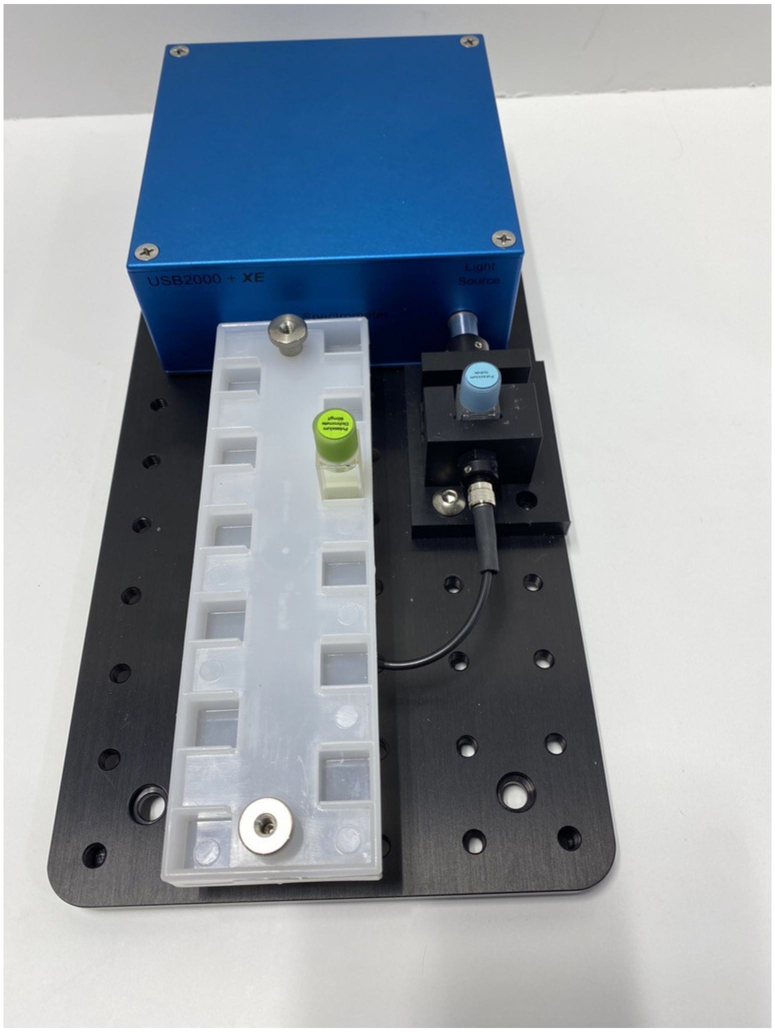

Fig. 2. USB2000+XE-CUV system that directly attaches a standard cuvette holder to the light source. A fiber is looped back to the spectrometer input. The cuvette tray servers to hold/organize the blank and samples and guards the fiber from being bumped. The whole system is rigidly mounted on a standard 6 X 12 inch bread board.

Check: Absorbance Only → Next
Click on Add/Remove Tab
Check: Continuous Strobe
UnCheck: Strobe/Lamp Enable
Click on Main Controls Tab

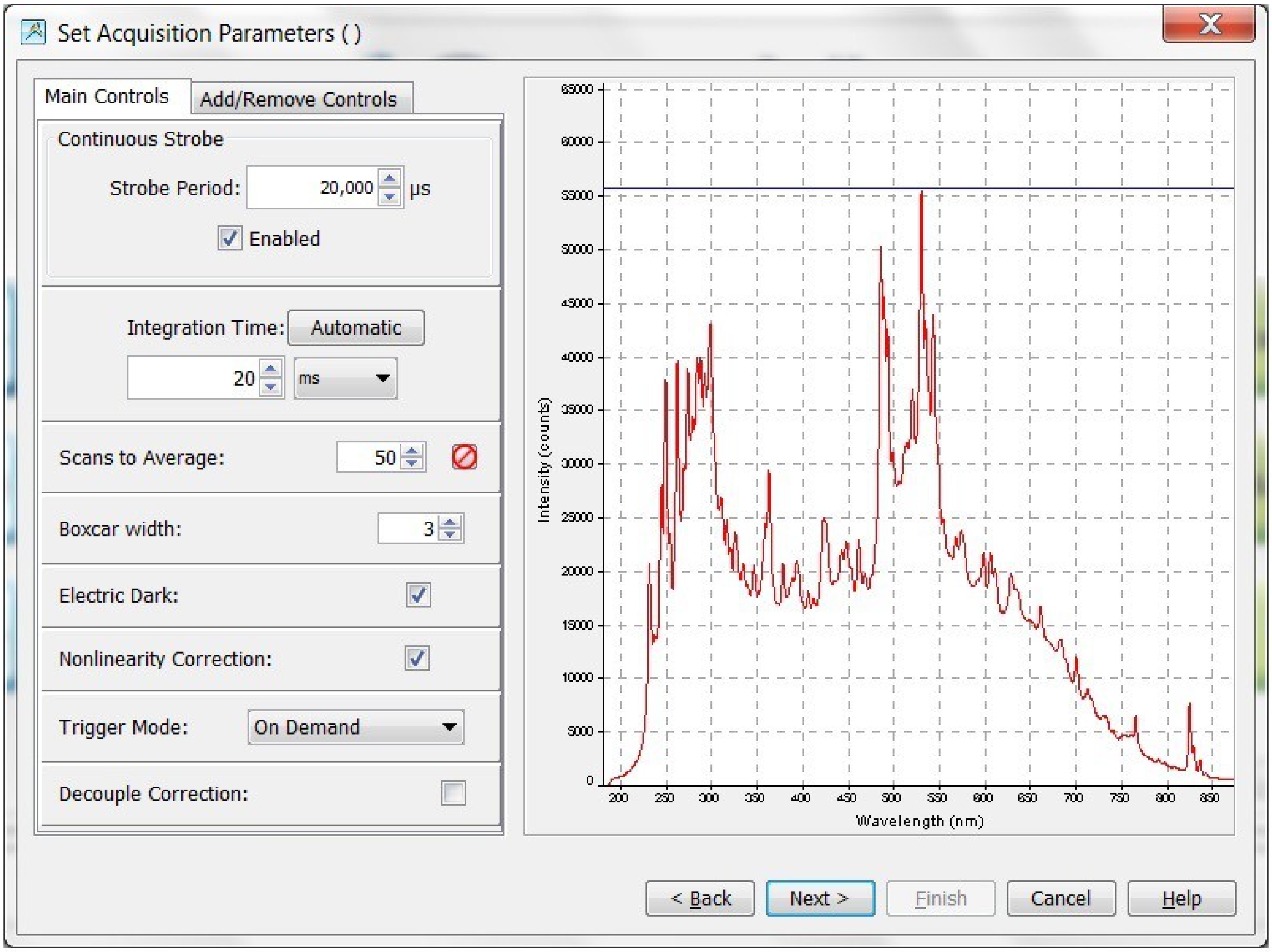

Fig.3. Setup for triggering a pulsed Xe lamp.

The integration time in Fig. 3 shows an acquisition every 20 ms which is now synchronous with the strobe period when the lamp is enabled (checked). If you doubled the integration time to 40 ms, then there would be 2 pulses per acquisition and the raw intensity counts would double. If you increased to the integration time to 30 ms, the traces would asynchronous, the raw traces would "dance" up and down showing unstable traces. Key point: if the integration time is increased it must be an integer multiple of the strobe period.

The scans to average are important to increase as much as possible. So keeping your integration times low to 20 ms allows you to increase the scans to Average of a 100 (or more). Non linear correction becomes important if your samples are highly absorptive (closer to 2A). CCDs will be non-linear at the extremes of either close to saturation (65000) or close to the dark level counts and have a transfer curves that is “S” shaped. The programmed non-linear coefficients (7^{th} order polynomial) corrects for the “S” roll offs both at the low and high ends of the response.

Hit Next:

Click: bright light icon, this stores the Ir (the reference) into the buffer.
Hit Next:
Uncheck the continuous strobe enable to turn off the lamp.
Click: dark light icon, this stores Id (dark level) into the buffer
Check the continuous strobe to turn the lamp back on.
Hit Finish.

On the absorbance tab you will see the baseline should be very close to Zero. You can re-zero the base line by hitting the bright light icon in the upper right corner. You will need to do this periodically before taking a measurement.

The Oceanview manual (help), will provide additional guidance on files, graph settings etc. The key point of this setup procedure is to describe how a pulsed lamp is setup in Oceanview. Any time you need to change your acquisition settings you can click on the “globe” tab for the acquisition parameters window.

By saving the project, this will allow you save you time setting up the triggering parameters the next time.

The example above was used with a USB2000+XE-CUV option which has large intensity margins when setting up the lamp. If you are using an integrating sphere with diffuse reflectance, the integration times will have be much longer since spheres have weak throughput. These types of applications would then limit your scans to average since integration times are long (seconds).

Some Useful Oceanview Tricks.

1. Many times we need to get quick data on a specific sample or on multiple samples when looking for a trend. One example, is to measure the same sample multiple times to see what the uncertainty is in the measurement or measuring three of four samples to see if there is a trend. Each time you click on the camera you store the active trace on the graph. So if you take multiple shots with the camera they will be labeled sequentially in the schematic window. In Fig. 4 you will see the camera shots in the schematic view. Each time you take camera shot you might want to immediately export that shot with a file name to keep the data (conditions) straight.

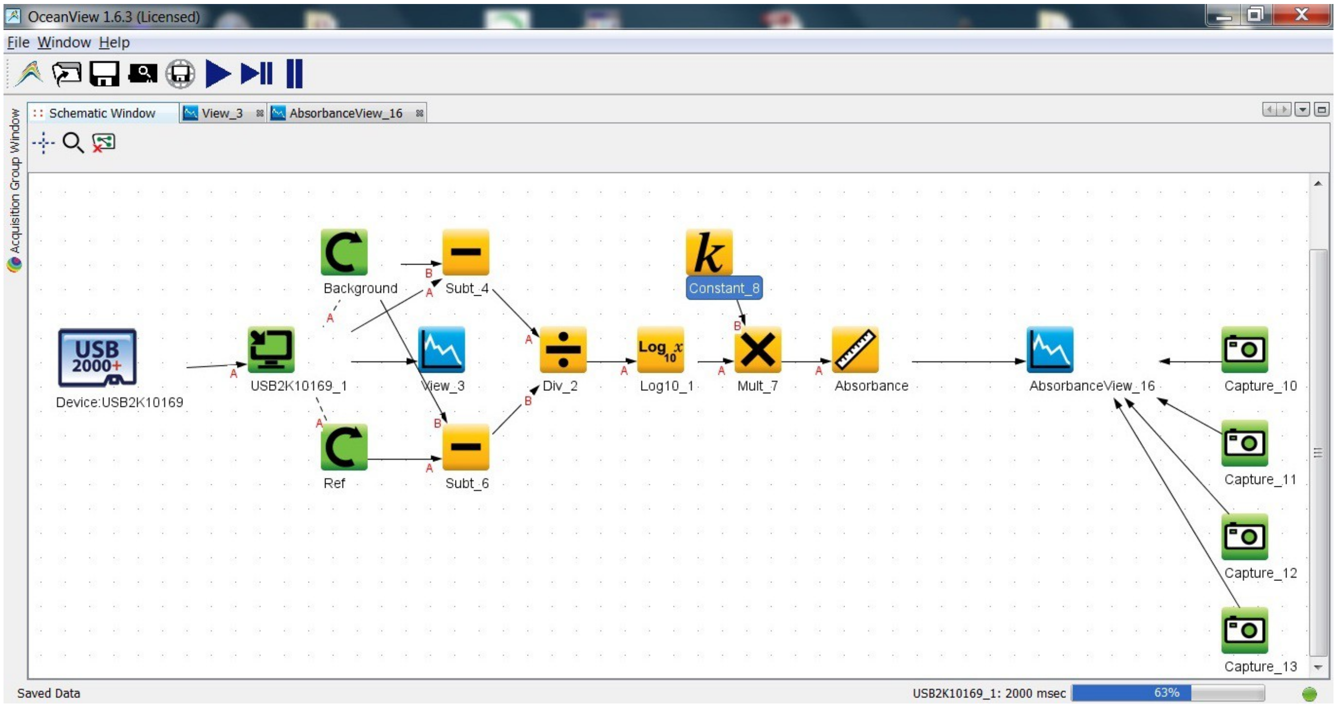

Fig. 4. Schematic view tab. The family of curves acquired through the camera capture can be accessed on the right. When you open these icons you can export each file (.txt format) to a specific location. To erase and clear these out right click on the each capture and delete. For detailed explanations on editing and modifying the schematic (e.g., adjusting constants etc.) see the Oceanview manual.

2. While in the absorbance window, you can also copy the active acquisition into the clipboard. Afterwards you can open Excel and directly paste into a column. This allows you to take multiple traces and either do numerical analysis or graph your results with more flexibility. This is a fast way to acquire your data and present it the way you need it.

3. If you only need a graphical format (to show a trend) you can also use Alt-Print screen and paste into Paint then export as a JPEG, PDF or other image type file.

Calibration.

While Ocean Insight offers calibration services on their spectrometers the turn around time may be too long. In Fig. 5 below is a typical output of the raw counts of a pulsed Xenon lamp. While the spikes are problematic for setting the integration time while avoiding saturation, the spikes are also used to check wavelength calibration.

Below is a list of useful Xenon Calibration Peaks across the 200-850 spectral range:

260.7 nm
362.5 nm
484.0 nm
823.2 nm

This will allow you to measure the wavelength accuracy by measuring the peak maximums in the raw trace as shown in Fig. 5.

If required, there are several other periodic calibration checks that can be made such as linearity and transmission/absorbance. These types of calibrations are best done with cuvette style standards that are offered by companies like Starna Cells. For example, if your application requires periodic checks with a known standard (NIST) we recommend you purchase the standards and keep them in-house.

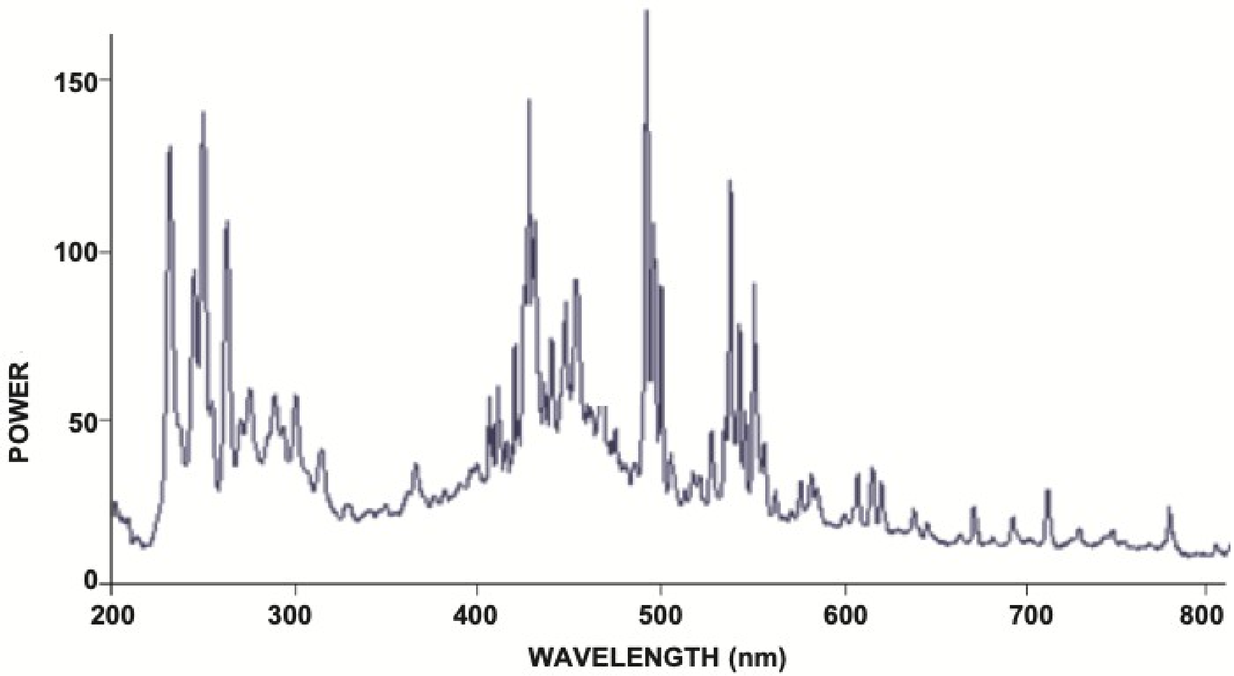

Fig. 5. Pulsed Xenon spectrum. There there several spikes with high intensity that can easily saturate the detector. However these spikes never change in line position (wavelength) and are useful for checking wavelength accuracy of the system.

Fibers and Installation.

The SMA fiber connection is recessed in the housing due to the design of the USB 2000+ spectrometer. When changing out fibers, care should be taken to never over tighten the fiber since the end of the ferrule is in direct contact with the slits. Over tightening can permanently damage the slits. We include a fiber wrench which is intended to aid in securing the fiber to the spectrometer as shown in Fig. 6.

If you intend to use Ocean Insight fibers, it is easier to use the laboratory grade fibers with plastic jackets. Like wise a hex nut is easier to install than a knurled nut. Finally avoid using fibers with a large boot since it makes it difficult to use any fiber wrench. In general keep the fiber lengths short, and be aware of the minimum bend radius with large core fibers (e.g., 600 um).

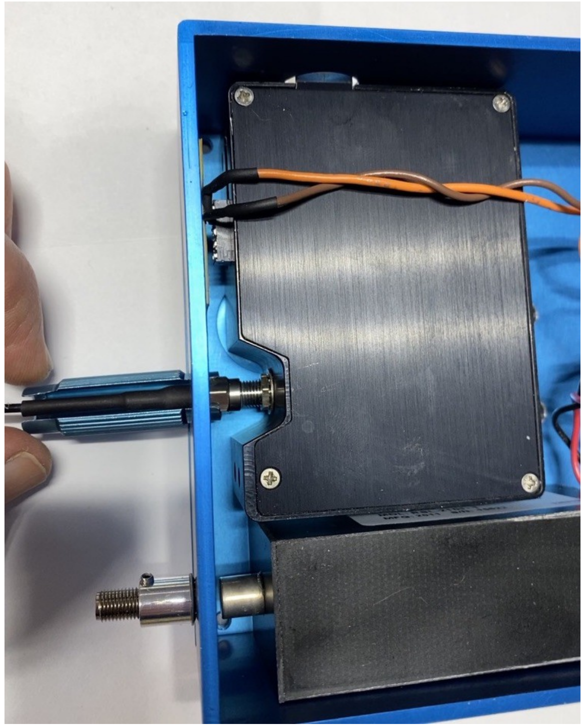

Fig. 6. Using a fiber wrench to install or remove the fiber from the spectrometer connection.