# Spectroscopy

## Optical Detection Systems



## Optical Detectors



## Light Sources



## Flow Cells



## Dipping Probes



## Optical Glass and Quartz Cuvettes for Spectrophotometry



## Accessories



## Optical Fibers



## Fiber Optic Sensors

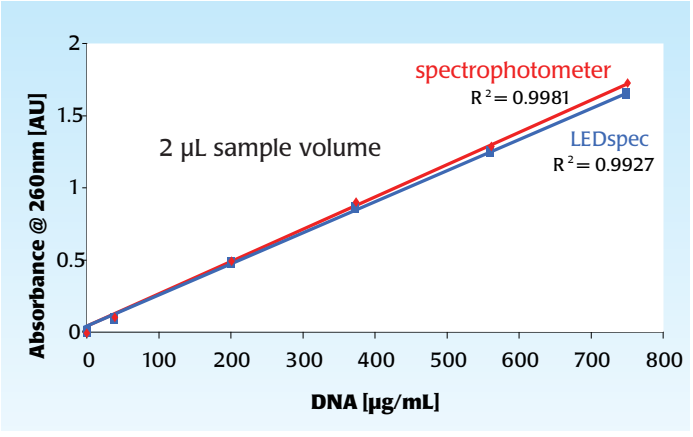
# Optical Detection Systems


*Cuvette and cuvette holder available separately.*

## Bio Photometric Detection System

**LEDspec** (visible) or **LEDspecUV** (ultraviolet) – Two unique photometers

- High Precision – performance exceeds that of CCD and photodiode array based spectrometers
- Affordable spectroscopy
- Simplified display with just the data you want to see
- Includes your choice of 3 wavelengths
- Install up to 7 wavelengths, **LEDspec** is easy to modify
- Order 2- or 4-channel
- Light source: LEDs — *no costly lamps to replace*




*DNA Calibration Curve using WPI's **V-Vette** combined with a **LEDspecUV** and pharmaceutical compliant spectrophotometer.*

### LEDspec

- Measures visible wavelengths
- Sample cells: **LWCC**, Fiber Optic Cuvette Holders, **V-Vette**
- Wavelength range (nm): 400, 450, 540, 560, 600, 650, 700, custom
- Applications include:

**Environmental/Oceanography**
Nitrite/Nitrate at 540nm
Phosphate at 700nm
Iron at 560nm

**Pharmaceutical**
Process Control

**Semiconductors**
Water purity, trace metal analysis (Fe, Pd, Cu, U)

### LEDspecUV

- Measures ultraviolet and visible wavelengths
- Sample cells: **LWCC**, **V-Vette**, Fiber Optic Cuvette Holder
- Wavelength range (nm): 260, 280, 340, 400, 450, 540, 560, 600, 650, 700, custom
- BSA, Lowry and Bradford assay capable
- Applications include all **LEDspec** applications, plus:

**Biochemistry**
DNA 0.5-1000ng/µL at 260nm (with WPI's v-Vette)
Protein: 0.1-30mg/mL at 280nm (with WPI's v-Vette)

**Pharmaceutical**
Drug discovery
Dissolution Testing

**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**


## Data You Want to See

Many **biochemistry** applications require information at specific, important wavelengths, instead of a full spectrum analysis. For example, the Bradford, BCA and Lowry assays for protein analysis rely on specific wavelengths.

LEDspec is ideally suited for **oceanographic** applications such as detecting nM concentrations of nitrite/nitrate, phosphate and iron using WPI's LWCC sample cells. Two or four independent channel FIA detection systems can be assembled using a **LEDspec-2** or **LEDspec-4**, respectively.

**LEDspec** and **LEDspecUV** are stand-alone LED-based bio-photometric detection systems designed to give you the information you want to see. Now you can conduct flow analysis and single-scan applications with **high precision** and a large **dynamic range**.

LEDspec can be equipped with **up to 7 LEDs** of different wavelengths.

Its noise (< 0.1 mAU peak to peak) and drift performance (<0.5 mAU/h) exceeds that of a CCD or photodiode array detection system **at a fraction of the cost**.

**LEDspec** uses dual–beams to **reduce light source drift**. Conventional single beam spectrometers notice baseline drift caused by warm up, temperature stability and bulb aging. A reference channel in the LEDspec corrects for baseline while you make sample measurements.

## Data Collection and Analysis

Now, you can analyze output data with **LEDspec**'s easy-to-use software and export chromatographs directly to your PC (via USB) in Microsoft® Excel format. Software provides:

- Full computer control of **LEDspec**
- Continuous flow or single-shot analysis of up to four independent channels simultaneously or sequentially.
- Immediate calibration and analysis (mean and standard deviation) of up to four channels

## LEDSPEC SPECIFICATIONS

| | |
|---|---|
| OPTICAL BASICS | LED-based multiple wavelength detector with build-in reference channel |
| CHANNELS | 2 or 4 |
| DETECTOR | Photodiode |
| SPECTRAL BANDWIDTH (FWHM) | 10 nm (LEDs >400nm)<br>4 nm (260, 280, 340nm LEDs) |
| DYNAMIC RANGE | 0-3 AU |
| DETECTOR RESOLUTION | 24 Bit |
| NOISE (PEAK TO PEAK) | < 0.1 mAU |
| WARMUP TIME | Instant |
| FIBER OPTIC INPUT | 600 µm |
| DRIFT | < 0.5 mAU/h |
| DIGITAL INPUTS AND OUTPUTS | 8/8 |
| ANALOG OUTPUT | +/- 10 V, scaleable output |
| DIMENSIONS (W*H*D) | 290 x 80 x 250 mm<br>(11.4" x 3.2" x 9.9") |
| WEIGHT | 2 kg (2.2 lbs) |
| INTERFACE | USB |
| MAINS | 100 – 240 V / 50 - 60 Hz |


| | |
|---|---|
| **LEDSPEC-2** | LEDspec biophotometric detection system (VIS), 2 channel, 3 LED modules (choose when ordering) |
| **LEDSPEC-4** | LEDspec biophotometric detection system (VIS), 4 channel, 3 LED modules (choose when ordering) |
| **LEDSPEC-2UV** | LEDspec biophotometric detection system (UV+VIS), 2 channel, 3 LED modules (choose when ordering) |
| **LEDSPEC-4UV** | LEDspec biophotometric detection system (UV+VIS), 4 channel, 3 LED modules (choose when ordering) |
| **89273** | LED module, 260 NM |
| **89272** | LED module, 280 NM |
| **89274** | LED module, 340 NM |
| **89245** | LED module, 400 nm |
| **89246** | LED module, 450 nm |
| **89247** | LED module, 540 nm |
| **89248** | LED module, 560 nm |
| **89275** | LED module, 600 nm |
| **89276** | LED module, 650 nm |
| **89249** | LED module, 700 nm |
| **LWCC-2200-LED** | LEDSPEC UPGRADE: LWCC-2200,2 fibers, sample injector kit (58006), waveguide cleaning kit (501609) |
| **LWCC-2050-LED** | LEDSPEC UPGRADE: LWCC-2050,2 fibers, sample injector kit (58006), waveguide cleaning kit (501609) |
| **LWCC-2100-LED** | LEDSPEC UPGRADE: LWCC-2200,2 fibers, sample injector kit (58006), waveguide cleaning kit (501609) |
| **PERIPRO-4L** | Peri-Star Pro, 4-channel, low rate, small tubing *(see page 2)* |
| **MINISTAR** | Miniature Peristaltic Pump, 1-channel *(see page 4)* |

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# UltraPath™

## *A unique multiple long pathlength sample cell for absorbance spectroscopy*


**● Process Control & Oceanography ● Rugged system for laboratory and onboard measuring ● Portable & easy to use ● User-selected optical path lengths: 2, 10, 50 & 200 cm ● Highly sensitive and stable**



**UltraPath™** is a unique high-performance spectrophotometer system offering user-selectable optical path lengths of 2, 10, 50 and 200 cm. The instrument operates in the wavelength range of 250 to 730 (**UPUV**) or 380 to 730 nm (**UPVIS**) and has an exceptional dynamic range. Designed for the detection of low absorbing species in aqueous solutions, UltraPath is an ideal tool for any study requiring precise and highly sensitive spectroscopic determination of analytes, either in the lab or in the field.

## Background

UltraPath was developed by WPI under a collaborative agreement with NASA (Stennis Space Center) for the spectroscopic determination of colored dissolved organic matter (CDOM) in seawater and fresh water environments. It can be used in the laboratory and in the field (*i.e.*, at sea). CDOM concentrations vary significantly between open ocean samples with low CDOM (*e.g.*, 0.007 $m^{-1}$ at 380 nm), and high CDOM freshwater environments (*e.g.*, 10-20 $m^{-1}$ at 380 nm). To address these problems the design requirements of UltraPath mandated the development of a rugged portable system capable of high sensitivity measurements across a wide dynamic range. The UltraPath system meets these stringent design criteria and enables reliable measurement of CDOM in the range of 0.002 $m^{-1}$ to 200 $m^{-1}$ (250 to 730 nm).

## Design

UltraPath has four optical pathlengths contained within a single sample cell (*i.e.*, 2 cm, 10 cm, 50 cm and 200 cm). The pathlengths are user-selectable, offering a very high sensitivity and an extended dynamic range for UV and VIS absorbance measurements. The fluid path of the sample cell is optimized to produce a laminar flow that is virtually free of interference from trapped air bubbles and adherence of dissolved substances to the cell wall. In particular, the design greatly minimizes the problems commonly found with flow cells of long optical pathlengths: the risk of trapping dust particles, fibers or particulate matter inside the cell. The UltraPath system includes a low noise photodiode array-based spectrometer module (TIDAS I: FWHM = 5 nm, noise <0.2 mAU) and a light source (**D2H** with UPUV; **FO6000** with UPVIS) to measure sample absorption. Light is coupled from the light source to the sample cell and from the sample cell to the detector via two fused silica fibers. A peristaltic pump (**PeriStar Pro**) is utilized to draw the sample into the UltraPath sample cell.

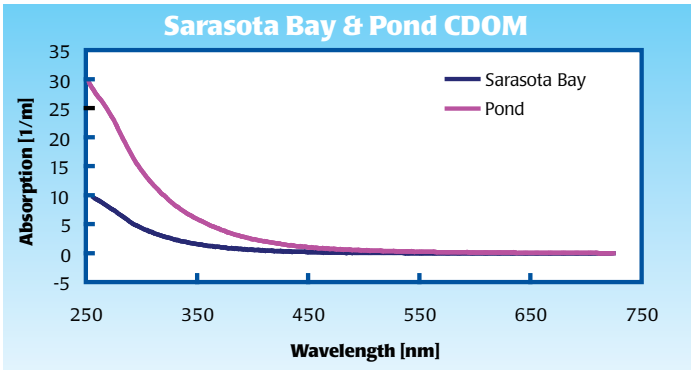


***Fig. 1 —*** *Two typical absorption spectra measured using UltraPath. The sample labeled "Sarasota Bay" is a CDOM sample with 34 PSU salinity collected from Sarasota Bay (Nov. 2007), and the sample labeled "Pond" is a highly concentrated CDOM sample collected from a local pond in Sarasota, Florida (Nov. 2007).*

**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**


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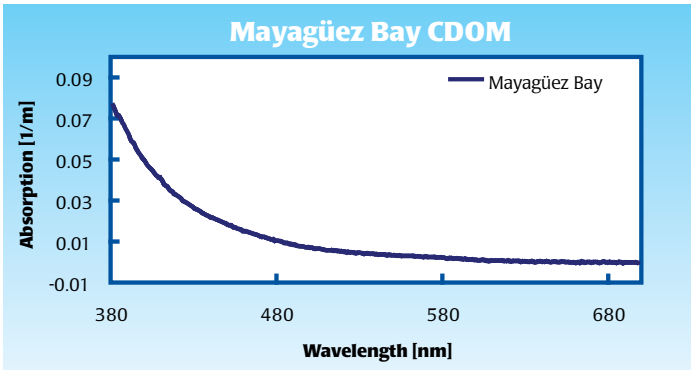



***Fig. 2 —*** *CDOM Sample "Mayagüez Bay" was collected from the high salinity oligotrophic waters of Mayagüez Bay on the west coast of Puerto Rico (2001). Data courtesy of NASA Stennis Space Center.*

A standard PC or laptop (not included) is connected to the TIDAS I via a RS232 interface (an RS232-to-USB2.0 adapter is included). For spectrometer requirements and software options, see **TIDAS-1**.

## Mobility

The system is designed for mobility. The components of the UltraPath system are designed to function over a broad range of laboratory and field environments.

## Samples

Two typical absorption spectra recorded with an UltraPath (UPUV) of a seawater and a fresh water sample collected in November 2007 are shown in Fig. 1. Due to their high absorbance, both samples were analyzed in the 10 cm pathlength. The CDOM sample labeled Mayagüez Bay in Fig. 2 is from oligotrophic, low productive waters with high salinity collected off the west coast of Puerto Rico in the Mayagüez Bay. Special attention should be drawn to the exceptional sensitivity of UltraPath enabling detection of CDOM absorption below 0.03 m-1. To exemplify the performance of the UltraPath in Laboratory Chemistry and Process Control, Ponceau S absorbance was measured with the 200 cm pathlength of an UltraPath. Normalizing the Ponceau absorbance graph to AU/cm, the range of this measurement is 150 µAU with a noise level below 2 µAU peak to peak. Sub-nanomolar concentration of this dye can clearly and reliably be detected, which is a novelty in absorbance based spectroscopy.

## Particulate Absorption

Particulate absorption can be measured by the well established Quantitative Filter Technique (QFT). WPI now offers a fiber optic filter holder for Glass Fiber Filters (**QFT1**, page 31) which can be used with the spectrometer (**TIDAS 1**) and light source (**D2H** or **FO6000**) supplied with the **UltraPath**. With this accessory, particulate absorption can be measured on site, avoiding loss of spectral information due to freezing and shipping particulate samples to a laboratory.

## Reference


N. B. Nelson, D. A. Siegel, C. A. Carlson, C. Swan, W. M. Smethie Jr. and S. Khatiwala. 2007. Hydrography of chromophoric dissolved organic matter in the North Atlantic. Deep-Sea Res. I. 54: 710 – 731.

V. Kitidis, A. P. Stubbins, G. Uher, R. C. Upstill Goddard, C. S. Law, E. M. S. Woodward, "Variability of chromophoric organic matter in surface waters of the Atlantic Ocean", Deep Sea Research Part II: Topical Studies, Vol. 53, Issue 14-16, 2006, p. 1666-1684.

R. L. Miller, M. Belz, C. Del Castillo, R. Trzaska, "Determining CDOM Absorption Spectra in Diverse Coastal Environments Using a Multiple Pathlength, Liquid Core Waveguide System", Continental Shelf Research, July 2002, 22:9, p 1301-1310.

"System Analyzes Water Samples at Sea", NASA Aerospace Technology Innovation, 2001, 9 (5). http://nctn.hq.nasa.gov/innovation/innovation95/3-techtrans2.html

R. L. Miller and E. D'Sa. "Evaluating the influence of CDOM on the remote sensing signal in the Mississippi River Bight". In Eos Transactions AGU Ocean Sciences, 2002. Honolulu, HI, p. 171.

E. D'Sa, R.L. Miller and R. Trzaska. "Aparent Optical Properties in Waters Influenced by the Mississippi River", Proceedings of the Seventh Thematic Conference, Remote Sensing for Marine and Coastal Environments, 2002, 6 pg, Miami, FL.

R. L. Miller, C. Hall, C. Del Castillo, B. McKee and M. Dagg. "Bio-optical Properties of the Mississippi River Plume and Adjacent Shelf." ASLO Aquatic Sciences, Albuquerque, NM, 2001.

R. L. Miller, M. Belz and S. Y. Liu, "Measuring the absorption of CDOM in the field using a multiple pathlength liquid waveguide system", Ocean Optics XV, paper 1308, Monaco, October 2000.

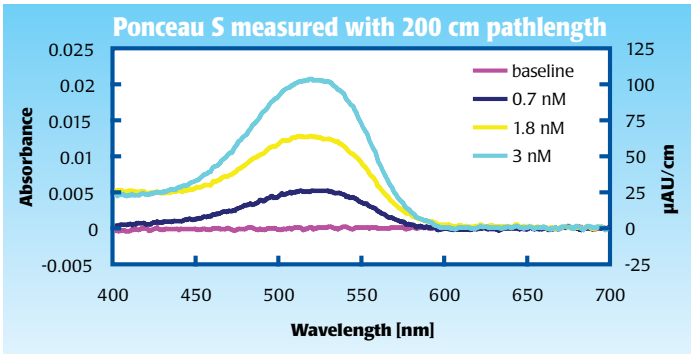




***Fig. 3 –*** *Ponceau S absorption measured with UltraPath (200 cm cell). Ponceau S was dissolved in Millipore water.*

## ULTRAPATH SPECIFICATIONS

| | |
|---|---|
| DYNAMIC RANGE | 5 µAU/cm to 1 AU/cm<br>0.002 $m^{-1}$ to 200 $m^{-1}$ |
| WAVELENGTH RANGE | 250 nm – 730 nm (UPUV)<br>380 nm – 730 nm (UPVIS) |
| WAVELENGTH RESOLUTION (FWHM) | 5 nm |
| NOISE (PEAK TO PEAK) | < 0.2 mAU |
| DRIFT | < 1 mAU/h |
| OPTICAL PATHLENGTH | 2, 10, 50 & 200 cm (user selectable) |
| SAMPLE CELL INNER DIAMETER | 2 mm |
| CELL VOLUME | 10 mL (at 200 cm pathlength) |
| SAMPLE INLET / OUTLET | 1/8" |
| FIBER INPUT/OUTPUT | 600 µm |
| SOLVENT RESISTANCE | Most organic and inorganic solvents |
| SHIPPING WEIGHT | UPUV: 44 lb (20 kg)<br>UPVIS: 33 lb (20 kg) |

| | |
|---|---|
| **UPVIS** | Ultrapath System, Visible Light |
| **UPUV** | Ultrapath System, Ultraviolet & Visible Light |

*The UltraPath system includes: Multiple pathlength cell, Tidas I with TidasDAQ/SpectraView software, FO-6000 light source (UPVIS) or D2H light source (UPUV), two FO-600-SMA1M optical fibers, PeriStar Pro peristaltic pump, silicone tubing, sample injector and Waveguide Cleaning Kit.*

***Specify line voltage***

| | |
|---|---|
| **501609** | Waveguide Cleaning Kit |
| **KIT-UPVIS-STARTUP** | FO-600-SMA1M, 501609, 72100, 800120, 15807 |
| **KIT-UPUV-STARTUP** | FO-600-SMA1M, 501609, 72100, D2H-DB, D2H-HB, 15807 |
| **89575** | QFT1, Fiber Optic Holder for Glass Fiber Filters |


- ***Photodiode array spectrometer module***
- ***Low noise detection (<0.1 mAU peak to peak)***
- ***Wavelength range 195 nm to 725 nm***
- ***Fiber optic design***

# Tidas I

## *High performance fiber optic spectrometer system*

WPI's **Tidas I** is a high end fiber-optic spectrometer module designed for low noise applications. The Tidas I outperforms conventional bench-based spectrophotometers and CCD-based spectrometer modules, when it comes to high precision fiber optic sampling. It relies on a monolithic optical bench made by Zeiss, which is optimized for fiber optic applications. Most cuvette-based standard spectrometers lose more than 90% of light through expensive prism decoupling. The TIDAS I is designed for fiber optic sampling cells. Using suitable light sources and sample cells, spectral detection in the wavelength range of 195 to 730 nm can be performed at noise levels < 0.1 mAU peak to peak.

### TIDAS I SPECIFICATIONS

| | |
|---|---|
| OPTICAL BASICS | Monolithic Spectrometer Module; Concave Aberration Corrected Holographic Grating; Fiber optic cross section converter for increased light throughput; 2nd order multi-layer filter |
| DETECTOR ARRAY | Hamamatsu photodiode array, 256 pixel |
| WAVELENGTH RANGE: | 195 - 725 nm |
| SPECTRAL BANDWIDTH (FWHM) | 5 nm |
| DETECTOR RESOLUTION | 16 Bit |
| NOISE (PEAK TO PEAK)* | < 0.1 mAU @ 550 nm with FO-6000 |
| WAVELENGTH ACCURACY | ± 0.2 nm |
| WAVELENGTH REPRODUCIBILITY | ± 0.07 nm |
| FIBER OPTIC INPUT | 600 µm |
| DIGITAL INPUTS AND OUTPUTS | 8/8 |
| SYSTEM REQUIREMENTS | Windows XP, Vista |
| SOFTWARE (INCLUDED) | TIDASDAQ (data collection) & SpectraView (data analysis) |
| DIMENSIONS (WxHxD) | 235 mm x 148 mm x 315 mm (9.25" x 5.8" x 12.4") |
| WEIGHT | 3.5 kg (7.7 lb) |
| INTERFACE | RS232 (USB adapter included) |
| POWER | 100 - 240 V / 50 - 60 Hz |

## Applications

The Tidas I is ideally suited for WPI's fiber optic sampling equipment. High sensitivity detection systems for flow analysis can be assembled using WPI's Liquid Waveguide Capillary Cells (**LWCC**) with effective pathlengths ranging from 2 to 500 cm. These setups are frequently used in fluid injection analysis systems for nutrient analysis (nitrite, nitrate, phosphate, iron) in oceanographic applications. Microliter sampling systems for UV/VIS applications can be assembled, using WPI's SpectroPipetter (SPT-2), or DipTip™ dipping probe. Such systems are ideally suited for direct DNA or protein detection of microliter samples at 260 nm and 280 nm wavelength in biochemistry applications.

## Software

There are separate software packages for data collection and data analysis for the TIDAS I. An instrument driver, **TIDASDAQ**, is used to run the spectrometer module, collect spectra in either single or continuous mode, control the digital I/Os and save the experimental data to disk. Data analysis is performed with the **SpectraView** software package. Further, TIDASDAQ exports data directly into GRAMS/AI, a feature very useful for advanced data analysis for pharmaceutical applications and requirements.

**TIDAS-I** Tidas I Spectrometer Module with TidasDAQ/SpectraView

**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**

## TidasDAQ: Data Collection and Instrument Control

With TidasDAQ, high precision intensity, absorbance, transmittance or normalized spectra can be obtained in less than a second. Only a few parameters need to be adjusted to obtain spectral data. Sampling of single scans, continuous full spectra scans or triggered scans is possible. Chromatograms can be displayed and logged to disk at up to four wavelengths. Data Export of 2D and 3D Spectrograms, as well as Chromatograms is supported in ASCII, Spectralys/SpectraView, Excel and Grams/ AI formats. Light sources and other sampling instrumentation can be controlled via the TTL level digital outputs, as well as data collection can be triggered by TTL leveled external inputs of the TIDAS I.

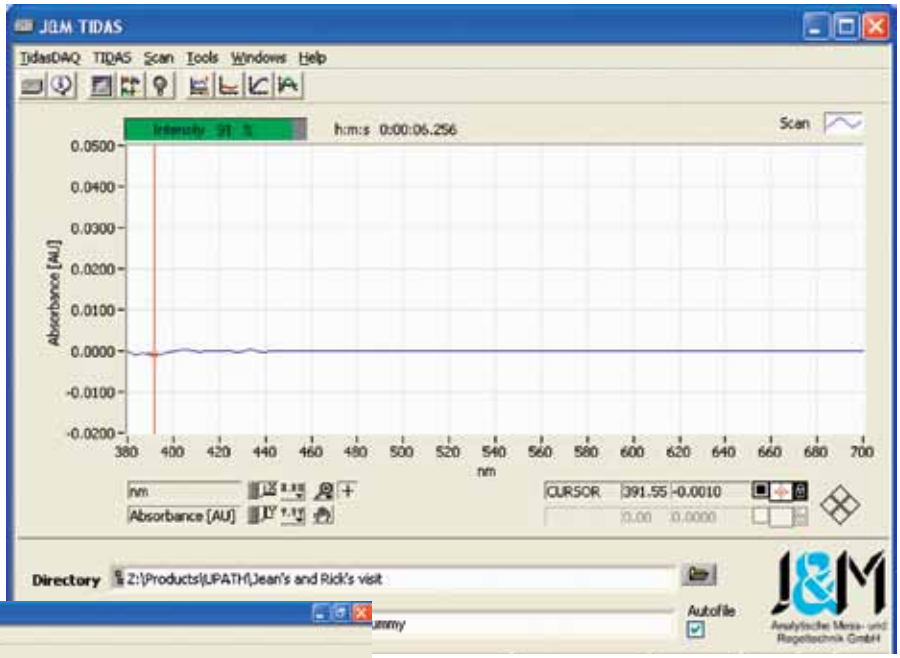



*Figure 1: TIDASDAQ acquisition window, showing an absorbance baseline.*

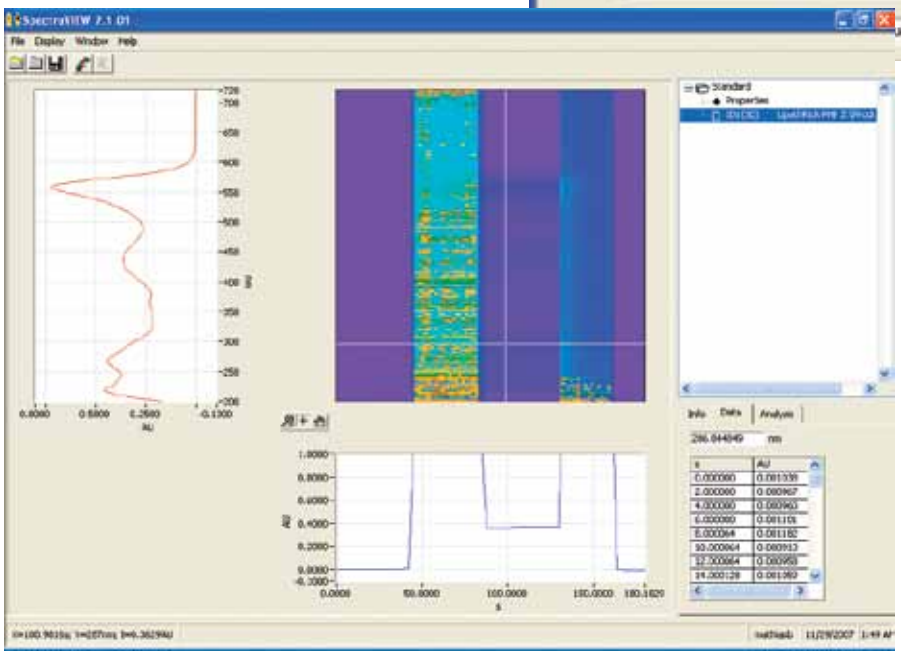


*Figure 2: SpectraView 3D view. Spectra can be displayed and analyzed in 2D and 3D format. This allows the user to conveniently interpret "time acquisition" data typically done with a TIDAS-1-LWCC flow system*

## SpectraView: Data Analysis

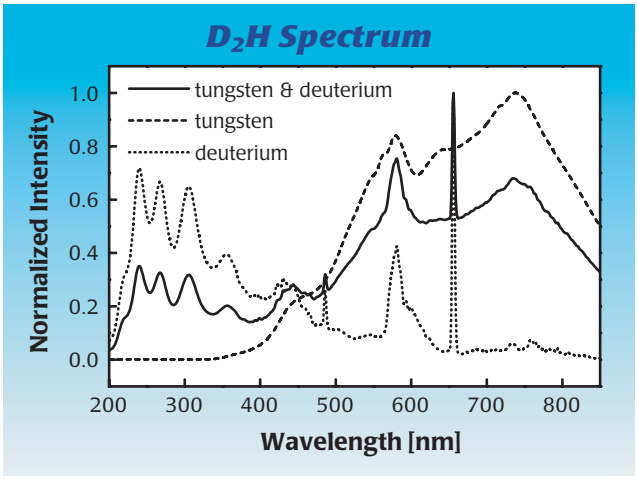
SpectraView is a spectroscopy data analysis package targeted at flow analysis applications. It processes data recorded by TIDASDAQ. SpectraView allows to display recorded spectra in 2D (default) and 3D view. Mathematical computation, Derivation, Smoothing, Quantification and other functions are available to work with your data. The Quantification module allows single point and multiple point analysis, multiple linear regression, partial least square and principle component analysis. Data can be exported out of a 3D analysis file into separate scans. Further, chromatograms as well as spectrograms can be copied directly into Excel for further data analysis.

**TIDAS-I-LWCC:** *See liquid waveguide capillary cell system on page 24.*

# Deuterium halogen light source with integrated TTL shutter


***Replacement Deuterium Lamp D2H-DB***

The **D2H** is a combined deuterium and halogen light source for UV/VIS and NIR applications. This light source is ideally suited to work with WPI's spectrometer modules and sample cells. It supplies a continuous spectrum in the UV, VIS and NIR range from 215 nm to 1700 nm. The D2H is equipped with an integrated electrical shutter, which can be controlled by a switch or a TTL signal. For deep UV applications (190-nm), the **D2H-2** should be used.




| | |
|---|---|
| **D2H** | Deuterium Halogen Light Source (215 nm–1700 nm) |
| **D2H-HB** | Halogen replacement lamp |
| **D2H-DB** | Deuterium replacement lamp ( > 215 nm) |
| **D2H-HBER** | Deuterium replacement lamp ( > 190 nm) |

## LIGHT SOURCE SPECIFICATIONS

| | $D_2H$ / $D_2H$-2 | FO-6000 |
|---|---|---|
| APPLICATION | UV/VIS/NIR | VIS/NIR |
| SPECTRAL RANGE | 215/190—1700 nm | 380—1700 nm |
| DEUTERIUM LAMP LIFE | 1000 hr | NA |
| TUNGSTEN/HALOGEN LAMP LIFE | 1000 hr | 3000* hr |
| STABILITY | 1-2 mAU/h | <0.5 mAU/h |
| POWER CONSUMPTION | 100 W | 6 W |
| POWER REQUIREMENTS | 110/240V, 50-60Hz, 1A | 12VDC/1A |
| SHUTTER/TTL TRIGGER | Yes | Yes |
| MAX. FIBER OUTPUT | 1000 µm | 1000 µm |
| CONNECTIONS | SMA | SMA |
| SHIPPING WEIGHT | 13.2 lb (6 kg) | 1.3 lb (0.6 kg) |
| DIMENSIONS (W/H/L) | 5.3 x 5.9 x 12.6 (13.5 x 15 x 32) | 4.8 x 2.8 x 7.5 (12 x 7 x 19) |

**Lamp life is dependent upon internal power settings.*

# UV Safety Goggles

***Goggles fit over regular glasses***

| | |
|---|---|
| **13410** | UV Safety Goggles |

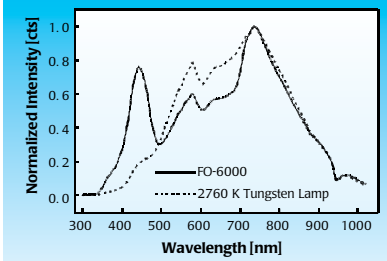
**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**

# FO-6000™

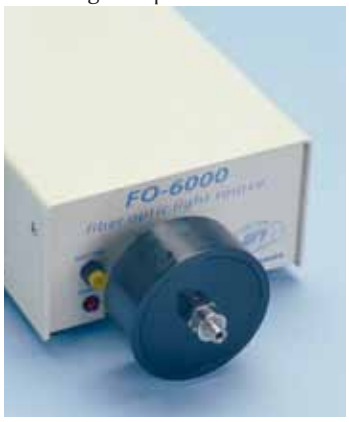
## *High color temperature tungsten light source*


This new miniature tungsten light source has been developed for high precision portable and low-power spectroscopy applications. Its advantage lies in its high light power output, its effective color temperature of 6000K and its exceptionally low drift below 0.5 mAU/h. The FO-6000 is a light source for the extended visible part of the light spectrum (380 nm – 1700 nm). It has a SMA type output connector. Shutter and lamp can be operated via TTL external triggering. This light source offers a wide assortment of field applications in analytical chemistry as well as environmental and life science.

### *FO-6000 Spectrum*




A significant problem with tungsten light bulbs is their inherent low light output at wavelengths below 430 nm. The FO-6000 was developed to overcome this limitation. The light intensity of a tungsten light bulb (2760K) drops below 10% at 420 nm wavelength. However, using FO-6000, the light intensity drops below 10% at 370 nm, where the intensity of the conventional tungsten light bulb is at approximately 2% relative light output. The inherent low noise and low drift of the FO-6000 makes it particularly suitable for low-noise detection systems.




## *FO-6000FILT*

The FO-6000FILT inline filter holder directly attaches to the FO-6000 light source. This allows a virtual light loss free insertion of optical filters with outer diameters from 8 to 25.4 mm and thickness ranging from 2 to 10 mm into the light path of the FO-6000. With this filter holder and an optical filter, a highly stable monochromatic light source can be assembled.

| | |
|---|---|
| **FO-6000** | Fiber Optic Light Source |
| **FO-6000FILT** | Inline Filter Holder Adapter for FO-6000 |
| **800120** | Replacement Lamp for FO-6000 |

# LED-Lite

## *Modular LED Light source with exchangeable LEDs*

The **LED-lite** is a power supply for WPI's **ELS** LED modules for monochromatic light excitation. Each ELS module has an SMA bulk head fitting and allows direct attachment of SMA terminated fibers.

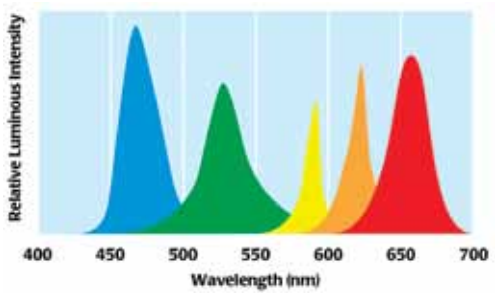

### ELS SPECTRAL DISTRIBUTIONS

| Color | $\lambda_{max}$ | Spectral Line Half Width | Estimated Output |
|---|---|---|---|
| UV | 370 nm | 12 nm | 85 µW |
| Blue | 430 nm | 65 nm | 15 µW |
| Blue | 450 nm | 70 nm | 119 µW |
| Blue | 470 nm | 20 nm | 140 µW |
| Blue-Green | 495 nm | 35 nm | 227 µW |
| Green | 525 nm | 40 nm | 80 µW |
| Yellow | 590 nm | 13 nm | 60 µW |
| Orange | 623 nm | 15 nm | 114 µW |
| Red | 660 nm | 35 nm | 275 µW |

*Estimated output is after light has passed through a 1 mm fiber.*

| | |
|---|---|
| **LED-LITE** | ELS Power Supply *(requires ELS module)* |
| | *Includes transformer and AC adapter.* |
| | ***Specify line voltage*** |
| **ELS-xxx** | External Light Source Module *(specify wavelength)* |
| **ELS-370** | ELS Module *(370 nm)* |
| **300051** | Fiber Optic Collimator (SMA) |
| **300052** | Fiber Optic Collimator (ST) |

***To order ELS, use wavelength as suffix to part number (e.g. ELS-430).***



**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**


# Liquid Waveguide Capillary Cell

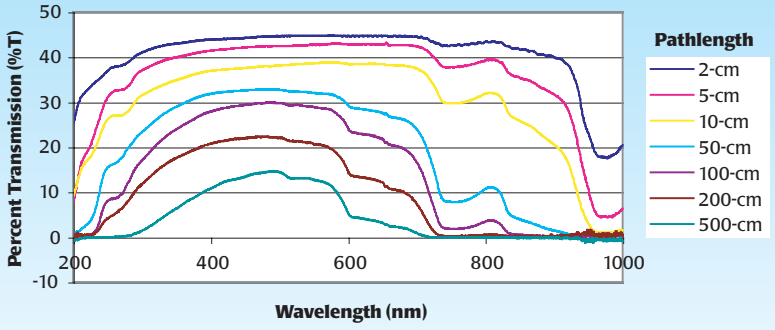
Liquid Waveguide Capillary Cells (**LWCC**) are fiber optic cells that combine an increased optical pathlength (2–500 cm) with small sample volumes (5–1250 mL). They can be connected via optical fibers to a spectrophotometer with fiber optic capabilities. Ultra-sensitive absorbance measurements can be performed in the ultraviolet (UV), visible (VIS) and near-infrared (NIR) to detect low sample concentrations in a laboratory or process control environment. According to Beer's Law the absorbance signal is proportional to chemical concentration and light path length. Compared with a standard 1 cm cell, a 1 mAU signal is enhanced fifty-fold with a 50 cm cell to 50 mAU, using WPI's patented aqueous waveguide

## LWCC Key Features

*Pathlength, internal volume, and wavelength range (measured with ultrapure water and a Tidas II spectrophotometer*

| | Pathlength [cm] | Internal Volume [µL] | Wavelength Range [nm] *measured with Tidas II* |
|---|---|---|---|
| **LWCC-2002** | 2 | 5 | 200-1000 |
| **LWCC-2005** | 5 | 12.5 | 200-1000 |
| **LWCC-2010** | 10 | 25 | 200-900 |
| **LWCC-2050** | 50 | 125 | 230-800 |
| **LWCC-2100** | 100 | 250 | 230-730 |
| **LWCC-2200** | 200 | 500 | 250-730 |
| **LWCC-2500** | 500 | 1250 | 280-730 |

## Typical Efficiency Curves for LWCC




*These spectra show the optimal detection limits for LWCCs of varying pathlength.*

## LWCC SPECIFICATIONS

| | |
|---|---|
| WAVEGUIDE MATERIAL | Fused silica tubing coated with a low refractive index polymer |
| OPTICAL PATHLENGTH | 2-500 cm |
| INNER DIAMETER | 550 µm |
| INTERNAL VOLUME | ≈ 5 - 1250 µL |
| SAMPLE INLET/OUTLET COMPRESSION FITTING | 1/16″, 1/32″ |
| FIBER INPUT | SMA, ID = 400 µm |
| MINIMUM PRESSURE* | 1.5 - 3 PSI |
| SOLVENT RESISTANCE | Most organic & inorganic solvents |
| SHIPPING WEIGHT | 1.4 kg (3 lb) |

**A one-meter Type II waveguide of 550 µm ID requires about 1.5 PSI for water flow of 1 mL/min.*

SPECTROSCOPY

**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**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# Ultra-sensitive Microliter UV/Vis Spectroscopy with 2 to 500 cm optical pathlength!


technology*. The LWCC can be connected directly to a pump or can even be filled using a syringe. Based on fiber optics, the LWCC is designed for use with WPI's **LEDspec** photometric detector *(see pages 16-17)*. Further, modular spectrophotometric sample systems can be assembled using a **TIDAS I** spectrometer and a UV/VIS light source such as **D2H** and **FO-6000** *(see pages 22-23)*.

## Applications

LWCCs have been used in a variety of applications, such as liquid chromatography, stopped-flow and colormetric detection, drinking water analysis, as well as environmental and oceanographic monitoring systems (see References on WPI website).

WPI's Liquid Waveguide Capillary Cells are made of fused silica tubing with an outer coating of a low refractive index polymer. This results in high signal stability and easy removal of air bubbles trapped in the sensor cell due to the hydrophilic character of the cell wall.

## LWCC Injection System

For flow analysis, including simple fluid injection analysis (FIA) setups, add WPI's LWCC injection system (WPI **#89372**). A selection valve provides baseline or cleaning solutions to the sample stream. The injection valve injects a sample into the stream, avoiding the introduction of air bubbles or changes of flow rate.

## * Related Patents

Micro Chemical Analysis Employing Flow Through Detectors, 1995, U.S. Patent No. 5,444,807.

Aqueous Fluid Core Waveguide, 1996, U.S. Patent No. 5,507,447.

Long Capillary Waveguide Raman Cell, 1997, U.S. Patent No. 5,604,587.

Chemical Sensing Techniques Employing Liquid-Core Optical Fibers, U.S. Patent No. 6,016,372

*Mote Marine Laboratories in Sarasota, Florida has partnered with WPI, using the Company's waveguide technology. WPI customized the LWCC installed in the instrument package inside these AUV's (Autonomous Underwater Vehicles). The LWCCs are used to monitor the color of seawater in the Gulf of Mexico. One of the primary interest areas of this research is red tide algae blooms.*


***Waveguide Cleaning Kit (#501609)**, above, includes the most commonly needed cleaning solutions for the LWCC waveguides. The **LWCC Start-up Kit (#KITLWCC)**, at right, includes two fiber optic cables (**#FO-400-SMA1M**), Sample Injector Assembly (**#58006**), Peri-Star™ Pro Peristaltic Pump, and WaveGuide Cleaning Kit (**#501609**).*

| | |
|---|---|
| **LWCC-2002** | Liquid Waveguide Capillary Cell, pathlength = 2 cm |
| **LWCC-2005** | Liquid Waveguide Capillary Cell, pathlength = 5 cm |
| **LWCC-2010** | Liquid Waveguide Capillary Cell, pathlength = 10 cm |
| **LWCC-2050** | Liquid Waveguide Capillary Cell, pathlength = 50 cm |
| **LWCC-2100** | Liquid Waveguide Capillary Cell, pathlength = 100 cm |
| **LWCC-2200** | Liquid Waveguide Capillary Cell, pathlength = 200 cm |
| **LWCC-2500** | Liquid Waveguide Capillary Cell, pathlength = 500 cm |

### ACCESSORIES

A sample injector assembly can be used to conveniently fill an LWCC with sample solution using a peristaltic pump. Please note that the LWCC requires two optical fibers to connect to spectrophotometer system. Choose between anti-solarized 400 micron core or UV-enhanced cables (may be ordered in 1 or 3 meter lengths).

| | |
|---|---|
| **89372** | LWCC Injection System |
| **58006** | Sample Injector Attachment |
| **PERIPRO-4L** | Peri-Star™ Pro Peristaltic Pump *(see page 2)* |
| **MINISTAR** | Miniature Peristaltic Pump, 1-channel *(see page 4)* |
| **FO-400-SMA1M** | Fiber Optic cable, 1m, SMA, 400 mm core, UV-enhanced |
| **501609** | Waveguide Cleaning Kit |
| **KITLWCC** | LWCC Start-up Kit* |
| **58450** | Kit, Adapter Syringe, LWCC |

**includes FO-400-SMA1M (two), 58006, PERIPRO-4L, 501609*

**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**

# V-Vette

## *Sample holder for spectroscopic analysis of microliter volume samples*

- 2 microliter sample
- 1 mm pathlength
- No moving parts
- Baseline repeatability < 2 mAU
- Patent pending

**V-Vette** is a fiber optic sample cell with a pathlength of 1 mm for spectroscopic analysis of microliter volume samples. Light is coupled into and out of the sample cell via optical fibers. A 2 µL sample droplet can be conveniently placed into the v-shaped sample compartment from a pipetter. Absorbance of the sample is measured between the input and output fiber after a cover is placed on the sample compartment to minimize stray light. The sample can be picked up and reused or removed by blowing it off with dry air or wiping it off.

| | |
|---|---|
| **V-VETTE** | V-Vette Microliter Sample Holder |

### V-VETTE SPECIFICATIONS

| | |
|---|---|
| FUNCTIONALITY | Absorbance |
| COVER | Included |
| PATHLENGTH | 1 mm |
| WAVELENGTH RANGE | 200 – 1000 nm |
| FIBER CONNECTION | 600 µm (SMA) |
| SAMPLE VOLUME | 2-5 µL |
| BASELINE REPEATABILITY | < 2 mAU peak to peak |

# MicroLWCC

## *Low volume flow cell for FIA, HPLC and Process Analysis*

MicroLWCC (WPI #**LWCC-M-10** and #**LWCC-M-50**) is a new fiber optic low volume flow cell for UV/VIS/NIR absorbance analysis. Based on WPI's established liquid core waveguide technology, the analyte solution functions as the core of a fluid filled light waveguide. Wetted parts in the sample cell light path are PEEK, fused silica and PTFE. Optical fibers are used to transport light to and from the sample cell. The cell can be used in biochemistry for DNA, RNA & protein quantification, colorimetric nutrient and trace metal analysis, drug discovery and dissolution testing, process control, and HPLC analysis.

### LWCC-M SPECIFICATIONS

| | LWCC-M-10 | LWCC-M-50 |
|---|---|---|
| OPTICAL PATHLENGTH | 10 mm | 50mm |
| INTERNAL VOLUME | 2.4 µL | 12 µL |
| WAVELENGTH RANGE | 200 – 1000 nm | |
| FIBER CONNECTION [µm] | 600 (SMA) | |
| TRANSMISSION @ 254 nm * | > 40% | |
| MAXIMUM PRESSURE | > 1000 psi | |
| REFRACTIVE INDEX @ 280 nm** | < 7 mAU | |
| WETTED MATERIALS | PEEK, Fused Silica, PTFE | |

* Reference: 2 * 600 um Fiber, butt-coupled

** Measured using ASTM E 685 - 93

WPI U.S. Patents: 5,444,807; 5,570,447; 5,604,587; 6,603,556; 6,385,380.

| | |
|---|---|
| **LWCC-M-10** | Low Volume Flow Cell, 10 mm pathlength |
| **LWCC-M-50** | Low Volume Flow Cell, 50 mm pathlength |

## References


M. Belz, "Simple and sensitive protein detection system using UV LEDs and liquid core waveguides", Advanced Environmental, Chemical, and Biological Sensing Technologies V, Optics East, Oct 2007, Proc. SPIE, Vol. 6755, 675505

M. Belz, F. A. Klein, H. S. Eckhardt, K. Klein, D. Dinges, K. T. V. Grattan, "Optical Detection Techniques and Light Delivery with UV LEDs and Optical Fibres", Third International Conference on Optical and Laser Diagnostics, Proc. IOP, City University, London, UK, May 2007.

M. Belz, P. Dress, A. Sukhitskiy, S. Liu, "Linearity and effective optical path-length of liquid waveguide capillary cells", Part of the SPIE Conference on Internal Standardization and Calibration; Architectures for Chemical Sensors, Boston Massachusetts, September 1999, SPIE Vol. 3856, 271-281.

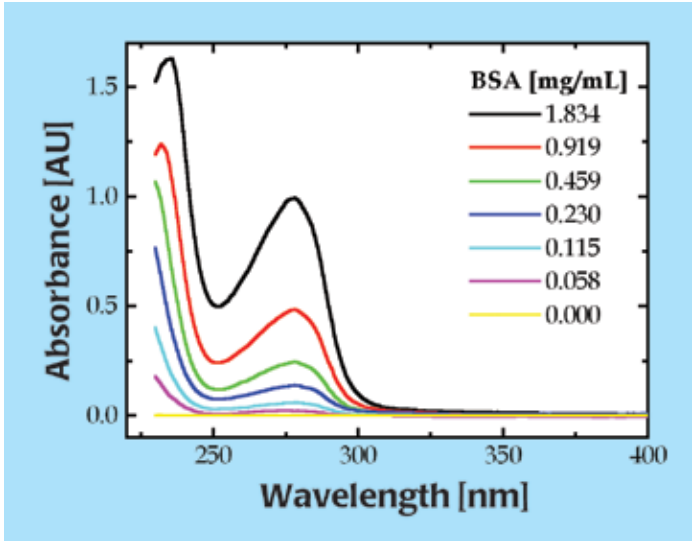


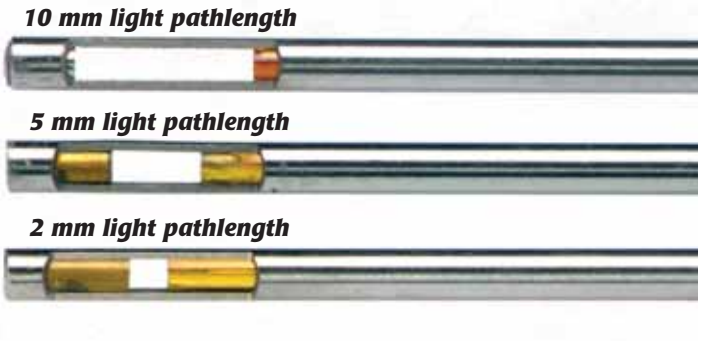

**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**

# Dipping Probes

## World's Smallest Fiber Optic Dipping Probe

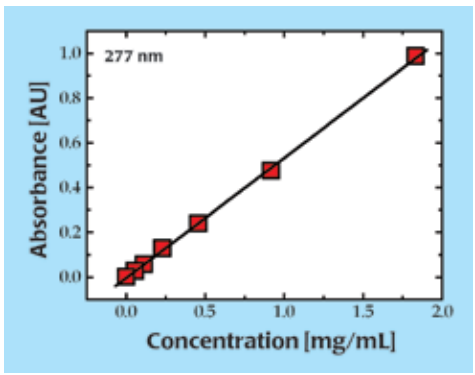
## for UV/Vis Spectroscopy




**DipTip™** is a miniature transmission probe for microliter spectroscopic sampling. DipTip's tip diameter is only 1.5 mm—the size of a 17-gauge needle. It will fit into all micro centrifuge tubes on the market and is a very useful tool for measuring protein and DNA samples. The diminutive dipping probe can also be used for a dissolution system. Thanks to WPI's proprietary optical design, DipTip is not only four to five times smaller in diameter than any other product on the market, but also costs 50% less. Together with our fiber optic-based spectrometer module (**Tidas I**) and light sources (**D2H** and **FO-6000**), microliter samples can be analyzed very cost effectively.

***Ideal for multi-channel applications.***




### DIPTIP SPECIFICATIONS

| | DIP-NIR | DIP-UV-SR |
|---|---|---|
| TIP DIAMETER | 1.5 mm | 1.5 mm |
| LIGHT PATHLENGTH | 2, 5, 10mm | 2, 5, 10mm |
| WAVELENGTH RANGE (nm) | 350-1000 | 200-1000 |
| SAMPLE VOLUME REQUIRED | 20-50 µL | 20-50 µL |
| DISTANCE FROM TIP TO UPPER EDGE OF SAMPLE WINDOW | 7 mm | 7 mm |
| FIBER LENGTH | 1.5 m | 1.5 m |
| FIBER OPTIC CONNECTION | SMA 905 | SMA 905 |
| LAUNCH FIBERS (2) NA = 0.22 | 400 µm | 400 µm |
| RETURN FIBER (1) NA = 0.22 | 400 µm | 400 µm |

| | |
|---|---|
| **DIP-NIRx** | DipTip™ for VIS/NIR Spectroscopy (2, 5, and 10mm path) |
| **DIP-UV-SRx** | DipTip™ for UV/VIS with solar resistant fibers (2, 5, and 10mm path) |
| **UCK** | Ultrasonic Cleaning Kit |

***Specify pathlength when ordering: X = 2, 5 or 10***

**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**

# Optical Glass and Quartz Cuvettes for

- ***High Quality Glass Cuvettes for less than $4/cuvette — $39/pack of 10***
- ***Standard Quartz Cuvettes for $39 each***
- ***Now offering an expanded line of standard, self-masking, and flow cuvettes!***

WPI's glass and synthetic quartz cuvettes are ideal for UV/VIS/NIR absorbance or fluorescence experiments.

Synthetic quartz can be used in deep UV applications and is recommended for fluorescent applications, as it does not exhibit background fluorescence. Quartz cuvettes (absorbance, fluorescence and flow) are shipped individually packaged, glass cuvettes are shipped in packages of 10 cuvettes. These economic quartz and glass cuvettes are ideal for precision measurements because of their high quality materials used and their low manufacturing tolerances. Typical transmission curves of glass and synthetic quartz cuvettes are shown in Fig. 1 (cuvettes were empty, thickness 1.25 mm x 2, including surface reflections, measured with a TIDAS II against air as reference).

A complete transmission spectrum from 190 nm to 4 mm is shown in Fig. 2 (cuvettes were empty, thickness 1.25 mm x 2, including surface reflections).

## TECHNICAL CHARACTERISTICS

| Cuvette Material | Spectral Range ( >80% ) | Transmission Difference Between Different Cuvettes |
|---|---|---|
| Optical Glass | 350 – 2500 nm | Less than 1% |
| Synthetic Quartz | 200 – 2500 nm | Less than 1% |

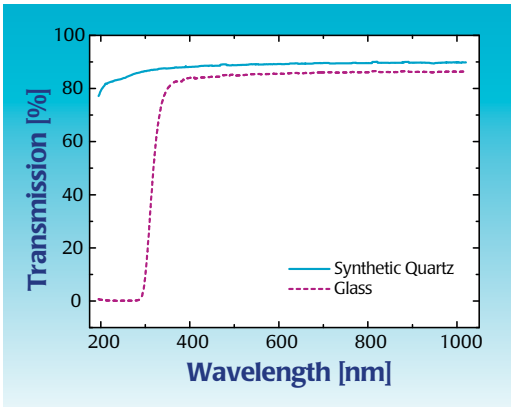



***Fig. 1—****Transmission curves of Glass and Synthetic Quartz Cuvettes*

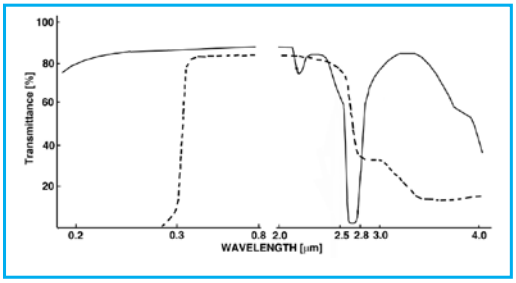



***Fig. 2—****Complete transmission curves of Glass and Synthetic Quartz Cuvettes*

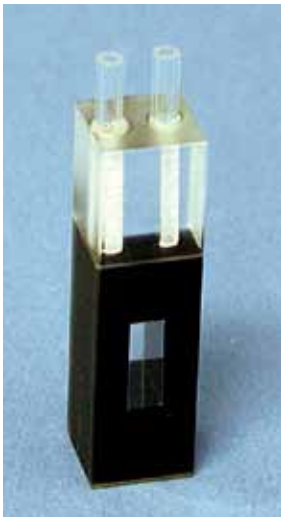

**Style A**


**Style B**


**Style C**

**Style D**

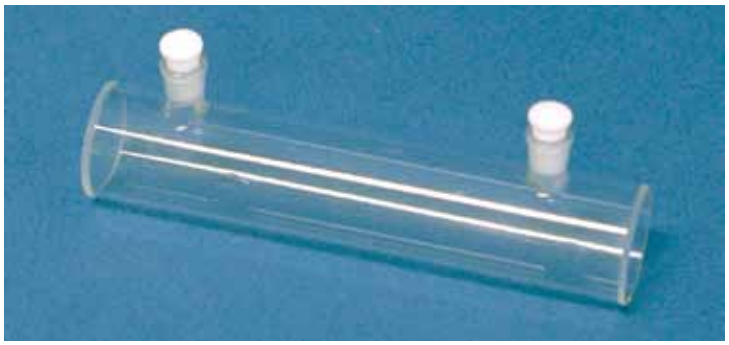
**Style E**



**Style F**

**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**

| WPI PN | Style | material | Polished windows | path [mm] | Dimensions [mm] | volume [mL] | Beam width [mm] | Price per cell |
|---|---|---|---|---|---|---|---|---|
| **standard rectangular cuvettes** | | | | | | | | |
| **CUV2101-1*** | B | Quartz | 2 | 1 | 3.5x12.5x45 | 0.35 | 10 | |
| **CUV2102-1*** | B | Quartz | 2 | 2 | 4.5x12.5x45 | 0.7 | 10 | |
| **CUV2011-1*** | B | Quartz | 2 | 5 | 7.5x12.5x45 | 1.7 | 10 | |
| **CUV1022-10** | C | Optical Glass | 2 | 10 | 12.5x12.5x45 | 3.5 | 10 | **pack of 10** |
| **CUV2012-1** | C | Quartz | 2 | 10 | 12.5x12.5x45 | 3.5 | 10 | |
| **CUV2105-1** | C | Quartz | 2 | 20 | 22.5x12.5x45 | 7 | 10 | |
| **CUV2106-1** | C | Quartz | 2 | 30 | 32.5x12.5x45 | 10.5 | 10 | |
| **CUV2107-1** | C | Quartz | 2 | 40 | 42.5x12.5x45 | 14 | 10 | |
| **CUV2108-1** | C | Quartz | 2 | 50 | 52.5x12.5x45 | 17.5 | 10 | |
| *__89341__ Cuvette spacer for 1-mm cuvettes (part **CUV2101-1**) | | | | | | | | |
| *__89342__ Cuvette spacer for 2-mm cuvettes (part **CUV2102-1**) | | | | | | | | |
| *__89337__ Cuvette spacer for 5-mm cuvettes (part **CUV2011-1, CUV2023-1, CUV2063-1**) | | | | | | | | |
| **Self masking Semi micro Cell Cuvette** | | | | | | | | |
| **CUV2023-1*** | D | Quartz | 2 | 5 | 7.5x12.5x45 | 0.7 | 4 | |
| **CUV2031-1** | D | Quartz | 2 | 10 | 12.5x12.5x45 | 1.4 | 4 | |
| **CUV2025-1** | D | Quartz | 2 | 20 | 22.5x12.5x45 | 2.8 | 4 | |
| **CUV2028-1** | D | Quartz | 2 | 50 | 52.5x12.5x45 | 7 | 4 | |
| **CUV2032-1** | D | Quartz | 2 | 10 | 12.5x12.5x45 | 1 | 3 | |
| **CUV2033-1** | D | Quartz | 2 | 10 | 12.5x12.5x45 | 0.7 | 2 | |
| **CUV2034-1** | D | Quartz | 2 | 10 | 12.5x12.5x45 | 0.35 | 1 | |
| **Self masking continuous flowthrough cell** | | | | | | | | |
| **CUV2063-1*** | E | Quartz | 2 | 5 | 7.4x12.5x45 | 0.035 | ∅ 3 | |
| **CUV2061-1** | E | Quartz | 2 | 10 | 12.5x12.5x45 | 0.07 | ∅ 3 | |
| **CUV2065-1** | E | Quartz | 2 | 20 | 22.6x12.5x45 | 0.14 | ∅ 3 | |
| **CUV2066-1** | E | Quartz | 2 | 30 | 32.6x12.4x45 | 0.21 | ∅ 3 | |
| **CUV2062-1** | F | Quartz | 2 | 10 | 12.5x12.5x45 | 0.48 | 4x12 | |
| **Self masking continuous flow through cell, small input, large output Z=8.5mm** | | | | | | | | |
| **CUV2614-1** | H | Quartz | 2 | 10 | 12.4x12.4x35.6 | 0.03 | ∅ 2 | |
| **Micro Cell with black walls** | | | | | | | | |
| **CUV2674-1** | J | Quartz | 2 | 10 | 12.5x12.5x45 | 0.05 | 2 | |
| **Fluorescence** | | | | | | | | |
| **CUV2051-1** | A | Quartz | 4 | 10 | 12.5x12.5x45 | 3.5 | 10 | |
| **CUV2052-1** | A | Quartz | 4 | 10 | 12.5x12.5x45 | 1.4 | 4 | |
| **Long Path Cuvette** | | | | | | | | |
| **CUV2071-1** | G | Quartz | 2 | 100 | 102.5 x 22 ∅ | 28 | 19 | |



**Style G**

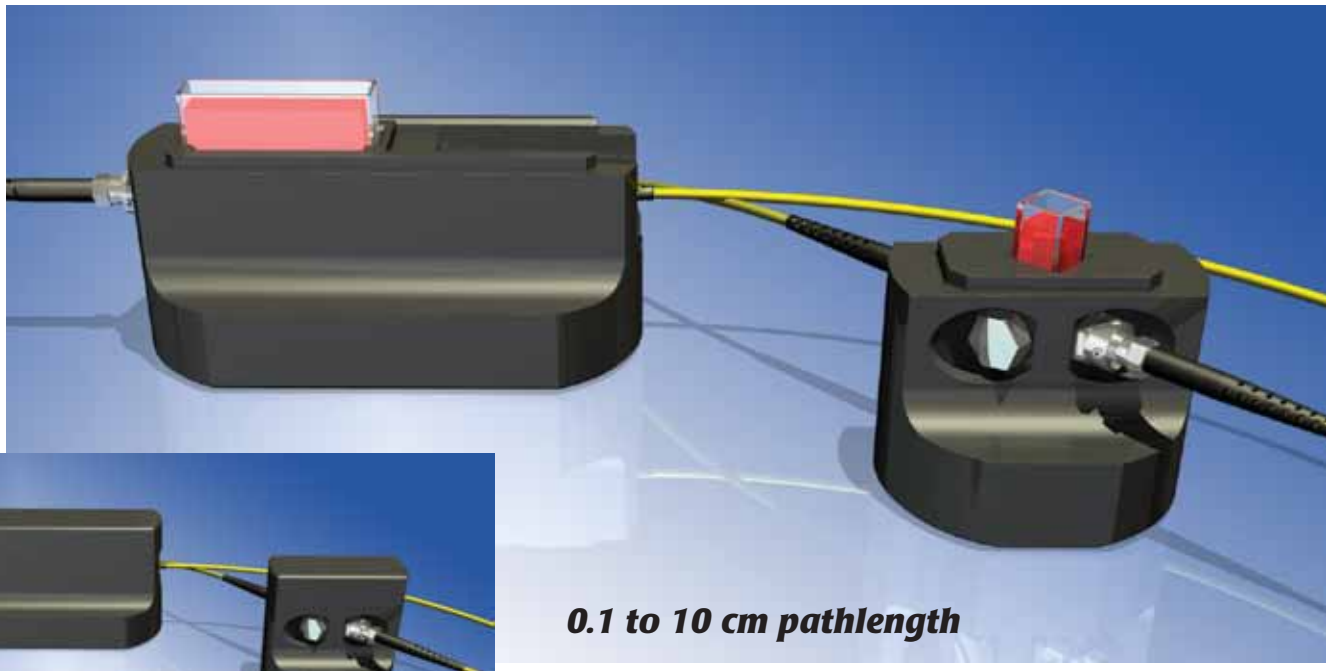
**Style H**

**Style J**

NEW CUVETTE HOLDERS page 220

Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

# High Precision Cuvette Holders





*0.1 to 10 cm pathlength*

| | WPI #89328 | WPI #89340 |
|---|---|---|
| **Description** | Adjustable Cuvette Holder | ABS/FL Cuvette Holder |
| **Functionality** | Absorbance | Absorbance & Fluorescence |
| **Cover** | Included | included |
| **Pathlength** | 1, 2, 3, 4, 5, 10 cm<br>1, 2, 5 mm with spacer | 1 cm,<br>1, 2, 5 mm with spacer |
| **Wavelength Range** | 200 – 1000 nm | 200 – 1000 nm |
| **Fiber Connection** | 50 – 1000 µm (SMA) | 50 – 1000 µm (SMA) |
| **Beam Diameter** | 5 mm | 5 mm |
| **Baseline Repeatability** | < 2 mAU peak to peak | < 2 mAU peak to peak |
| **WPI Cuvette Types** | A, B, C, D, E, F, G, J | A, B, C, D, E, F, J |
| **Z – height** | 15 mm | 15 mm |

WPI's cuvette holders address the need for precision sampling with specialty cuvettes in Absorbance and Fluorescence applications.

- High precision cuvette positioning for low volume cuvettes.
- Quartz lenses for high light throughput.
- WPI #89328 fits 1, 2,3,4,5 & 10 cm standard and cylindrical cuvettes.
- WPI #89340 can be configured for absorbance or fluorescence experiments.

**89339** Mirrored screw plugs, ea.

SPECTROSCOPY

# In-Line Fiber Optic Filter Holder

This In-Line Fiber Optic Filter Holder allows the insertion of optical filters within a fiber optic pathway. The connectors of the filter holder assembly are compatible with WPI's range of fiber optic jumper cables and can be coupled using SMA or ST connectors.

Filters with outer diameters from 8 to 25.4 mm and thicknesses from 2 to 10 mm can be accomodated. The design limits lateral and axial movement of the filter when secured in the holder.

Two fiber optic collimators are internally mounted in the holder to pass collimated light through the filter and then refocus the filtered light into the aperture of the output fiber. Spectral range will be largely limited by the bandpass of the optical fibers (from UV to near IR using WPI UV-enhanced cables).

**56200** In-Line Fiber Optic Filter Holder (SMA)
**56300** In-Line Fiber Optic Filter Holder (ST)

**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**

# Filter Holder for Glass Fiber Filters

QFT1

QFT2

## Simple measurements for particulate absorption

WPI's filter holder for particulate absorption measurements is specially designed for field use. It is rugged and portable. It performs as well as a laboratory based spectrophotometer. It can be directly connected to WPI's line of fiber optic spectrometers and light sources. Instead of collecting your samples, transporting them to a laboratory, and accepting the loss of spectral information associated with it (Sosik, 1999), particulate absorption can now be measured on site.

**QFT1**, an optical holder for glass fiber filters, allows you to measure absorbance of particulate matter concentrated on a glass fiber filter pad. The **QFT2** is a QFT1 with an integrated 1cm cuvette holder, which allows for on-site liquid sample measurements, as well.

## How does it work ?

Particulate absorption of fresh and seawater can be determined by filtering a known amount of sample through a Glass Fiber Filter (GF/F) and measuring the particulate absorption coefficient $a_p(\lambda)$ concentrated on the filter. This technique is called quantitative filter technique (QFT) and corrects for the pathlength amplification, an effect of scattering. The correction of the pathlength amplification and the correction of the non-linear relationship between the optical density of samples on a Whatman GF/F filter and in suspension are discussed in Mitchell (1990).

## Advantages of QFT1

WPI's filter holder for glass fiber filters is designed for fiber optic use. It is rugged and portable and can be used in the field.

## Specifications

| | |
|---|---|
| GF/F Filter Diameter | 25 mm |
| Wavelength Range | 280-730 nm * |
| Fiber Optic Connection | ∅ 600 µm / SMA |
| Material in contact with filter pad | Delrin |
| Weight | 0.5 kg (1 lb) |

** Using a TIDAS I spectrometer and D2H UV/VIS light source.*

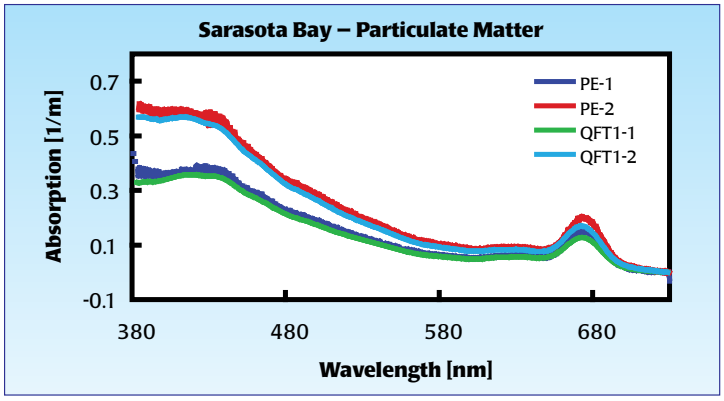
## Detector and light source requirements

The optical throughput of QFT1 equipped with a classical GF/F filter is very low and requires a matched light source / spectrometer system. WPI's **TIDAS I** in combination with WPI's **FO-6000** tungsten light source or **D2H** deuterium/ halogen light source can be used in the 380–730 nm and 280–730 nm wavelength range, respectively. Further, the QFT1 can be interfaced with WPI's **SpectraUSB4** CCD spectrometer line. The QFT1 can also be interfaced to any other CCD, PDA or scanning type spectrometer with fiber optic capabilities.

## Performance

To test the performance of the QFT1, seawater samples were collected locally and filtered through a GF/F filter pad. The particulate absorption was measured with the QFT1 and for comparison with a Lambda 35 UV/VIS spectrometer equipped with a RSA-PE-20 integrating sphere attachment. The measured particulate absorbance spectra overlay well for a number of samples.

A significant advantage of the filter holder is its large beam diameter of 5 mm, resulting in "averaging out" of larger non-organic particles frequently found on the filter pad when using natural samples. The removable filter fixture allows simple filter alternation and cleaning.




***Particulate absorption of seawater samples collected in Sarasota Bay.***

## References


Mitchell, B. G., "Algorithms for Determining the Absorption Coefficient of Aquatic Particles Using the Quantitative Filter Technique (QFT)", SPIE Vol. 1302 *Ocean Optics X* (1990), 137-148.

Sosik, H. M., "Storage of marine particulate samples for light-absorption measurements", *Limnol. Oceanogr.*, 44(4), 1999, 1139-1141

M. Belz, K. Larsen, K.-F. Klein, "Fiber optic sample cells for polychromatic detection of dissolved and particulate matter in natural waters", *Proc. SPIE,* Vol. 6377, Oct 2006, 63770X


| | |
|---|---|
| **89575** | QFT1, Fiber Optic Holder for Glass Fiber Filters |
| **89385** | QFT2, Fiber Optic Holder with Cuvette Holder |

**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**

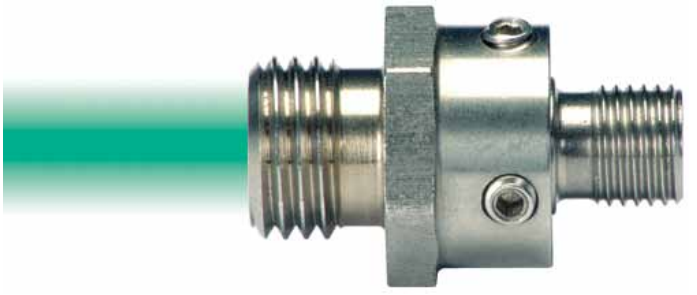
# Fiber Optic Adapter

## *For UV1000 and UV2000 Thermo Electron HPLC Detectors*

This fiber optic adapter is designed for Thermo Electron's UV1000/UV2000 series of HPLC detectors. It allows for an efficient connection of WPI's fiber optic sampling equipment via two SMA-905 connectors. Instead of using the standard 1 cm flow cell, WPI's line of liquid waveguide capillary cells with pathlengths from 2 cm to 500 cm can be attached. This is a cost-effective way to equip existing UV1000 or UV2000 detectors in the lab with fiber optic sampling cells. For example, using a **LWCC-2200** with a 200 cm optical pathlength, the sensitivity of the detection system is increased 200-fold, enabling very sensitive flow injection analysis setups. A baseline noise performance of approximately 1-2 mAU is achievable with such a setup.

| | |
|---|---|
| **59609** | Fiber Optic Adapter for UV1000 & UV2000 |

# Fiber Optic Collimator



WPI's Fiber Optic Collimator can be used for both collimating a light beam emitted by an optical fiber or coupling light from a collimated light beam into an optical fiber. The numerical aperture of the collimator is optimized for maximum coupling efficiency into typical fused silica fibers. The collimator can, for example, be used to guide a parallel light beam through a sample cuvette or an optical filter with virtually no optical losses. In this application, one collimator collimates the light into a parallel beam 5 mm in diameter, enabling it to pass a long distance without losing the energy. After the light passes the sample media, a second collimator can be used to collect the beam into the receiving fiber. A unique design feature of this collimator is that the distance between the lens and the optical fiber can be easily adjusted. This permits it to be used as a focusing device or for fine-tuning the color balance when coupling light from a light source into a fiber.

### COLLIMATOR SPECIFICATIONS

| | |
|---|---|
| LENS DIAMETER | 5 mm |
| LENS FOCAL DISTANCE | 10 mm |
| LENS MATERIAL | Ultraviolet grade synthetic fused silica (KU-1) |
| WAVELENGTH RANGE | 170 nm-2 µm |
| MOUNTING THREADS | 3/8-24 UNF |
| DIVERGENCE | < 0.1 rad for 1 mm core fiber |
| FIBER CONNECTOR INTERFACE | SMA or ST |

| | |
|---|---|
| **300051** | Fiber Optic Collimator (SMA) |
| **300052** | Fiber Optic Collimator (ST) |

# Plastic Fiber Optic Cables

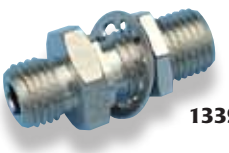
More flexible than glass fibers, these inexpensive PMMA plastic fibers can be used for illumination and scientific applications. They are excellent for light transfer between 350 nm and 1000 nm. Their maximum temperature should be kept below 80° C.

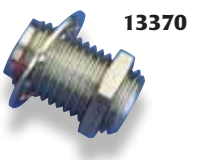
**PLASTIC FIBER OPTIC CABLES (NON UV), 400 TO 1000 NM**

| | |
|---|---|
| **FOP1-SMA** | Plastic Fiber Optic Cable, SMA connectors, 1 mm x 2 m |
| **FOP1-SMA/ST** | Plastic Fiber Optic Cable, ST/SMA connectors, 1 mm x 2 m |
| **FOP1-ST** | Plastic Fiber Optic Cable, ST connectors, 1 mm x 2 m |

**OPTIONAL ACCESSORIES**

| | |
|---|---|
| **13395** | SMA Bulkhead Feedthru connector/coupler, D-hole |
| **13370** | SMA half-length Bulkhead coupler/connector |
| **CC-3-UV** | Cosine Corrector |


**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**

# Bifurcated Fiber Optic Assemblies

Use to combine similar intensity light from differing sources or to split a light source into two fibers. For use with a dual spectrometer as a reference.


### BIFURCATED ASSEMBLY SPECIFICATIONS

| | |
|---|---|
| Length | 1 meter |
| Connectors | SMA |
| Wavelength ranges | 200-1100 nm |
| Cable Type | UV-enhanced |

| | |
|---|---|
| **BIF22** | Split or combine similar intensities (200/200) |
| **BIF44** | Split or combine similar intensities (400/400) |
| **BIF41** | Combine UV (400) + VIS (100) |
| **BIF62** | Combine UV (600) + VIS (200) |
| **BIF66** | Split or Combine Similar Intensities (600/600) |

**WPI can build custom fiber optic assemblies for many UV/VIS/NIR applications. Call for more information.**

# UV-enhanced fiber optic cables

### Features

● Broad UV/Vis spectral range ● Laser damage resistant ● High core to clad ratios ● Broad temperature range ● Bio-compatible materials ● Radiation resistant ● Sterilizable by ETO and gamma radiation ● Higher transmission than PCS between 180-nm and 300 nm

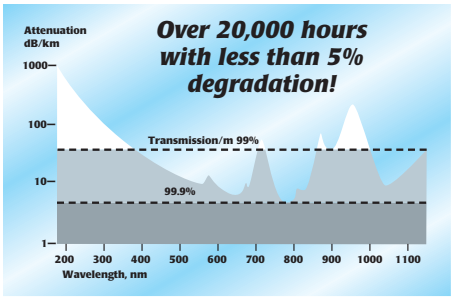
### Properties

- Multimode • Pure silica core • Numerical aperture: 0.22 ± 0.02 (standard)
- Standard prooftest: 70 kpsi • Minimum bend radius: 100x clad radius (momentary), 600x clad radius (long term)

### Anti-Solarization

The transmission of conventional UV-enhanced silica/silica fiber decreases rapidly at wavelengths below 240 nm when exposed to high intensities of a deuterium lamp. This effect is called "UV-solarization" and results from the generation of color centers in the fiber material. The lifetime of such a fiber, defined by the 1/e reduction in transmission at 240 nm, is normally less than 200 minutes. This effect renders them unsuitable for UV spectroscopy below 240 nm.

Anti-solarization fibers suitable for deep UV spectroscopy solve this problem. These fibers stabilize to less than 5% degradation over a period of 20,000 hours after an initial transmission "burn-in" loss of less than 25%. Additionally, this anti-solarization characteristic will not degrade over time.




### UV-ENHANCED FIBER OPTIC CABLES, 230 – 1000 NM

| | |
|---|---|
| **FO-50-SMA1M** | Fiber Optic Cable, 1 m, SMA, 50 µm Core, UV-Enhanced |
| **FO-50-SMA** | Fiber Optic Cable, 3 m, SMA, 50 µm Core, UV-Enhanced |
| **FO-100-SMA1M** | Fiber Optic Cable, 1 m, SMA, 100 µm Core, UV-Enhanced |
| **FO-100-SMA** | Fiber Optic Cable, 3 m, SMA, 100 µm Core, UV-Enhanced |
| **FO-200-SMA1M** | Fiber Optic Cable, 1 m, SMA, 200 µm Core, UV-Enhanced |
| **FO-200-SMA** | Fiber Optic Cable, 3 m, SMA, 200 µm Core, UV-Enhanced |
| **FO-400-SMA1M** | Fiber Optic Cable, 1 m, SMA, 400 µm Core, UV-Enhanced |
| **FO-400-SMA** | Fiber Optic Cable, 3 m, SMA, 400 µm Core, UV-Enhanced |
| **FO-400SMA/ST** | Fiber Optic cable, 1 m, SMA/ST connector, 400 µm core, UV-Enhanced |
| **FO-600-SMA1M** | Fiber Optic Cable, 1 m, SMA, 600 µm Core, UV-Enhanced |
| **FO-600-SMA** | Fiber Optic Cable, 3 m, SMA, 600 µm Core, UV-Enhanced |
| **FO-1000-SMA1M** | Fiber Optic Cable, 1 m, SMA, 1000 µm Core, UV-Enhanced |
| **FO-1000-SMA** | Fiber Optic Cable, 3 m, SMA, 1000 µm Core, UV-Enhanced |

### ANTI SOLARIZATION FIBER OPTIC CABLES, 190 – 1000 NM

| | |
|---|---|
| **FO-200AS-SMA** | Fiber Optic Cable, 1 m, SMA, 200 µm Core, Anti-Solarization |
| **FO-400AS-SMA** | Fiber Optic Cable, 1 m, SMA, 400 µm Core, Anti-Solarization |
| **FO-600AS-SMA** | Fiber Optic Cable, 1 m, SMA, 600 µm Core, Anti-Solarization |

### PLASTIC FIBER OPTIC CABLES (NON UV), 400 TO 1000 NM

| | |
|---|---|
| **FOP1-SMA** | Plastic Fiber Optic Cable, SMA connectors, 1 mm x 2 m |
| **FOP1-SMA/ST** | Plastic Fiber Optic Cable, ST/SMA connectors, 1 mm x 2 m |
| **FOP1-ST** | Plastic Fiber Optic Cable, ST connectors, 1 mm x 2 m |

**Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.**