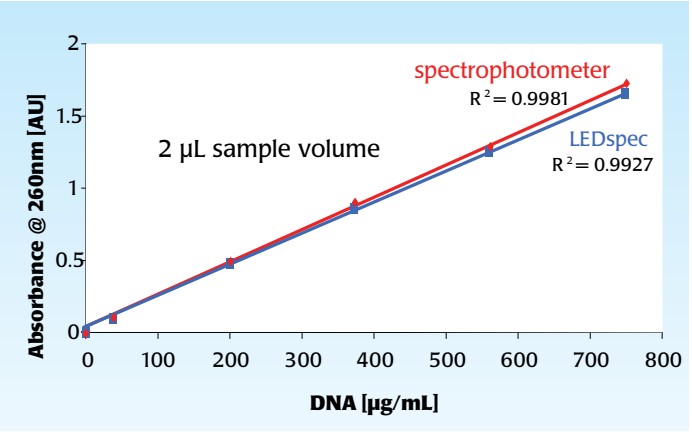
Optical Detection Systems

Bio Photometric Detection System

Choose the wavelength data you want to see. In many nutrient, water purity and process applications, full spectrum analysis is not required. With LEDspec you can eliminate the extraneous data and focus on those wavelengths you need to see. You can conduct flow analysis and single-scan applications with high precision over a large dynamic range.

- Affordable spectroscopy
- Dynamic range and baseline noise outperform CCD and photodiode array based spectrometers
- LED light source eliminates costly replacement lamps
- Integrated reference channel eliminates signal drift
- Full computer control
- Integrated math functions allow for baseline correction at a second wavelength, signal ratio and more
- Simplified display with just the data you want to view
- Your choice of three wavelengths included

Two models are available: 2-channel and 4-channel. LEDspec-2 (2-channel) comes with your choice of three LED modules (wavelengths). LEDspec-4 (4-channel) also includes your choice of three LED modules, however, up to four additional wavelengths can be added, if desired.



*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
Ammonia at 650nm

Pharmaceutical
Process Control

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

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 is a stand-alone LED-based bio-photometric detection system 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. An internal reference channel in the LEDspec corrects for baseline while you make sample measurements.

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) 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 (11.4" x 3.2" x 9.9")
WEIGHT	2 kg (2.2 lbs)
INTERFACE	USB 2.0
MAINS	100 – 240 V / 50 - 60 Hz

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-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)
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
PERIPRO-4LS	Peri-Star Pro, 4-channel, low rate, small tubing *(see page 166)*
MINISTAR	Miniature Peristaltic Pump, 1-channel *(see page 168)*

UltraPath™

A unique multiple long pathlength sample cell for absorbance spectroscopy

Appearance of instruments presently in these systems differ from those pictured here.

● 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 (**D4H** 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 (**PeriPro-4LS**) is utilized to draw the sample into the UltraPath sample cell.

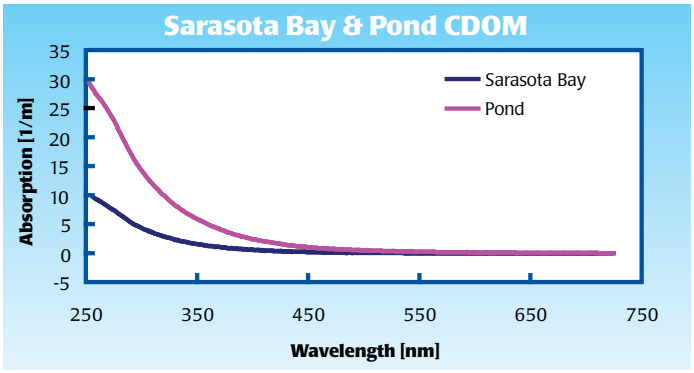


Fig. 1 — *Two typical absorption spectra measured using UltraPath. The sample labeled "Sarasota Bay" is a CDOM sample with 34 PSU salinity collected from Sarasota Bay (Nov. 2007), and the sample labeled "Pond" is a highly concentrated CDOM sample collected from a local pond in Sarasota, Florida (Nov.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

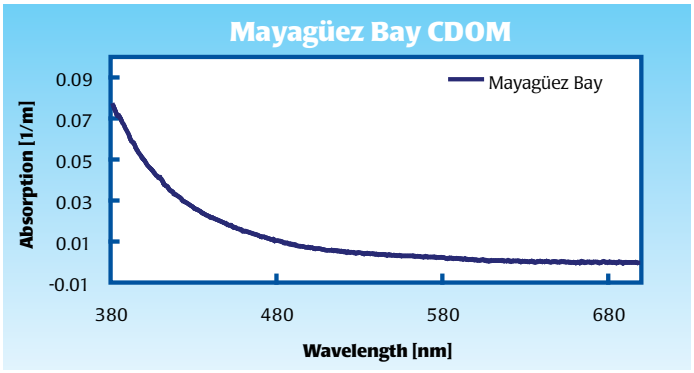


Fig. 2 — *CDOM Sample "Mayagüez Bay" was collected from the high salinity oligotrophic waters of Mayagüez Bay on the west coast of Puerto Rico (2001). Data courtesy of NASA Stennis Space Center.*

A standard PC or laptop (not included) is connected to the TIDAS E via a RJ-45 Ethernet interface). For spectrometer requirements and software options, see **TIDAS-E**.

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 206) which can be used with the spectrometer (**TIDAS E**) and light source (**D4H** 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.

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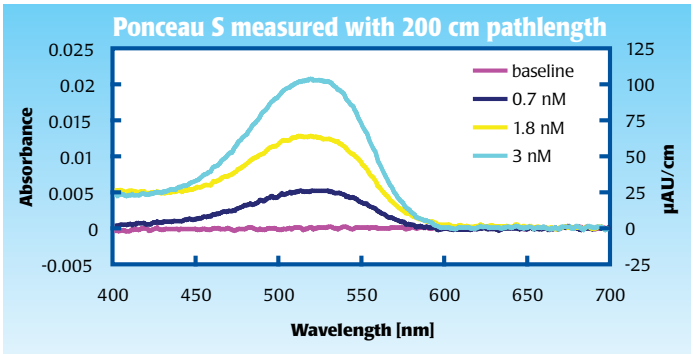


Fig. 3 – *Ponceau S absorption measured with UltraPath (200 cm cell). Ponceau S was dissolved in Millipore water.*

ULTRAPATH SPECIFICATIONS

DYNAMIC RANGE	5 µAU/cm to 1 AU/cm 0.002 m^{-1} to 200 m^{-1}
WAVELENGTH RANGE	250 nm – 730 nm (UPUV) 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) UPVIS: 33 lb (20 kg)

UPVIS	Ultrapath System, Visible Light
UPUV	Ultrapath System, Ultraviolet & Visible Light

The UltraPath system includes: Multiple pathlength cell, Tidas E 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

Optical Detectors

- ***Photodiode array spectrometer module***
- ***Low noise detection (<0.1 mAU peak to peak)***
- ***Wavelength range 190 nm to 720 nm***
- ***Fiber optic design***

Tidas E

High performance fiber optic spectrometer systems

WPI's **Tidas E** is a high end photodiode array-based spectrophotometer including a light source, a cuvette holder and fiber optic coupling. Its companion is the **TIDAS E Base**, a fiber optic spectrometer module with a fiber optic connector for modular spectrometer systems.
The Tidas family of spectrophotometers and spectrometer modules 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 E is designed for fiber optic sampling cells. Using suitable light sources and sample cells, spectral detection in the wavelength range of 190 to 720 nm can be performed at noise levels <0.04 mAU peak to peak.

Applications

The Tidas E 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 50 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 **V-Vette** or **DipTip™** dipping probes.

Software

TidasDAQ 3 software is included with each instrument for data collection and data analysis. TidasDAQ is used to run the spectrometer module, collect spectra in either single or continuous mode, control the digital I/Os, save the experimental data to disk, and analyze the data. Further, TidasDAQ can export data directly into GRAMS/AI, a feature very useful for advanced data analysis for pharmaceutical applications and requirements.

Wavelength Range	Resolution	Wavelength Accuracy	TIDAS E BASE	Light Source	TIDAS E	Light Source
UV 190-390 nm	< 3 nm	±1 nm	**504717**	no	**504720**	UV
UV/VIS 190-720 nm	< 7 nm	±1 nm	**504718**	no	**504721**	UV / VIS
VIS/NIR 300-1100 nm	< 10 nm	< 3 nm	**504719**	no	**504722**	VIS
Integrated Cuvette Holder			no			yes
Number of Pixels	256					
Dimensions	260 x 150 x 140 mm					
Weight	2.5 kg					
Power Supply	100 - 240 VAC / 47 - 63 Hz					
Digital I/O	2 x IN / 2 x OUT					
Optical Fiber Connection	SMA 905					

Includes power supply, TIDAS DAQ software, RJ-45 cable, and manual

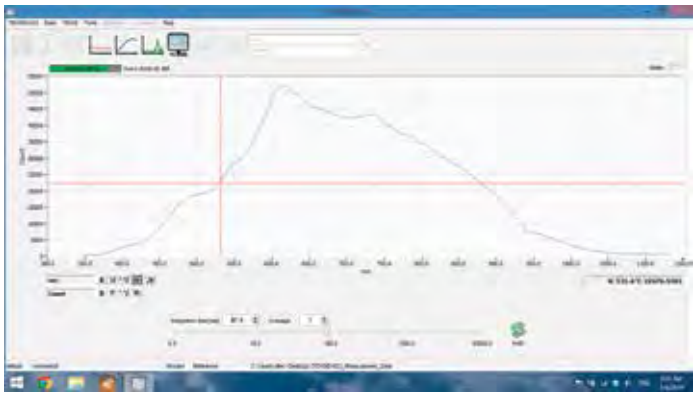


Figure 1: TIDASDAQ acquisition window, showing an absorbance baseline.

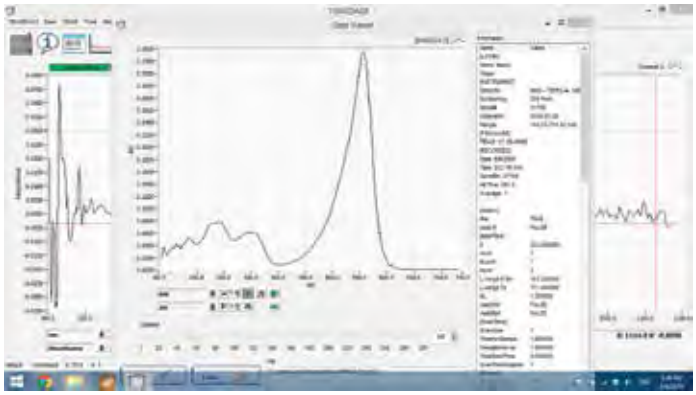


Figure 2: Spectra can be displayed and analyzed in 2D and 3D format. This allows the user to conveniently interpret "time acquisition" data typically done with a TIDAS-E-BASE-LWCC flow system.

TIDAS E 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
DETECTOR RESOLUTION	16 Bit
NOISE (PEAK TO PEAK)*	< 0.04 mAU @ 254 nm
WAVELENGTH ACCURACY	<1 nm
WAVELENGTH REPRODUCIBILITY	< 0.1 nm
FIBER OPTIC INPUT	600 µm
SYSTEM REQUIREMENTS	Windows XP, 7, 8
SOFTWARE (INCLUDED)	TIDASDAQ
DIMENSIONS (WxHxD)	260 mm × 150 mm × 140 mm (10.25" × 5.9" × 5.5")
WEIGHT	2.5 kg (5.5 lb)
INTERFACE	External (RJ-45)
POWER	100 - 240 V / 50 - 60 Hz

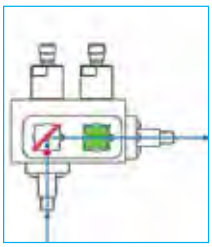
TidasDAQ: Data Collection & Instrument Control

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 E.

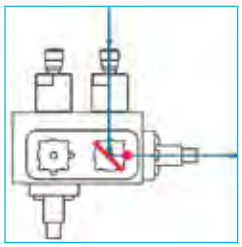
Spectra can be recorded in 2D and 3D view. Mathematical computation, Derivation, Smoothing, Quantification and other functions are available to work with your data. The Quantification module allows single point and multiple point analysis, multiple linear regression, partial least square and principle 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.

The TIDAS E Optical Path

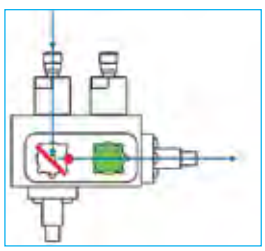
With help of the patented cuvette holder and the mirror cuvette, various measurement setups are possible in conjunction with either internal or external light source. The patented cuvette holder and the external measurement setup can be simultaneously used. The flexibility of the design of TIDAS E is manifested below in various possible options of measurements using different optical paths formed by combinations of cuvette holder, mirror cuvette, optical fiber and light sources.



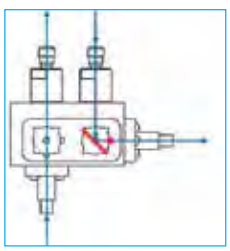
The light radiates from the internal light source, and is conducted from the redirected mirror, through the cuvette holder, into the correct detector. The measuring sample can be located in the second cuvette chamber.



From the internal light source, radiated light passes through the cuvette holder and illuminates through the external measuring cell. The light is redirected through the cuvette holder and channelled through the detector.



The light from the external light source is coupled over the cuvette holder and redirected over the mirror cuvette to the detector; thereby the sample in the standard cuvette chamber can be measured.



The light from the external light source is coupled over the cuvette holder and redirected over the mirror cuvette to the detector.

Biofluorometer

The new **SI-BF100** is an LED-based fluorometer for life science applications. It is ideally suited for ratiometric calcium detection (FURA-2) and ATPase detection (via NADH fluorescence). With up to seven LED modules (wavelengths), the **SI-BF100** covers many fluorometric applications in neuroscience and cell biology.

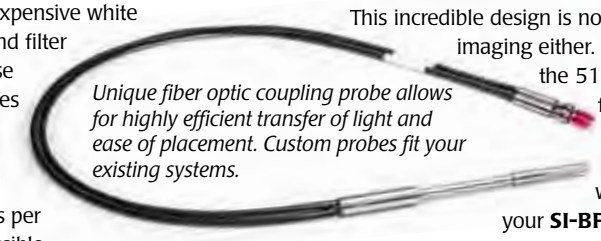
Recent advancements in optics and LED technology simplify ratiometric calcium imaging, making this equipment more affordable. A breakthrough in WPI patented technology allows the **SI-BF100** to use wavelengths below 380nm and produce more light in those spectra. This technology significantly cuts the cost of photometric calcium imaging without sacrificing resolution or quality.

- LED light sources require less power, give off less heat and are more compact and affordable
- Sampling rates up to 1kHz (1,000 ratios/second maximum). At lower speeds, signal averaging is used for noise reduction.
- Two auto ranging photomultiplier inputs allow you to monitor multiple wavelengths from a single emission output that can be comprised of any wavelength of light for which an LED module is available
- Using a separate reference channel, ultra-stable, continuous ratio calculations automatically compensate for LED intensity drift. This ensures less noise and produces more accurate measurements.
- Application-specific probes are available for existing tissue baths and cuvette systems.
- Ratio noise is <0.05 peak to peak, drift is less than 0.1 unit/hour
- The warm up time of less than one minute is a dramatic improvement over the common 20–60 minutes required by xenon or mercury light sources
- Replace the emission filter easily or change the LED modules to transform the **SI-BF100** into a general purpose fluorometer for many other applications

How it Works

Up till now, calcium imaging systems have been required to compensate for errors and noise introduced by the complexity of their design. The systems require mechanical filters and use expensive xenon or mercury light sources. The beauty of the **SI-BF100** is its simplicity. The elegance of its design reduces the noise introduced into the system and the errors inherent in traditional designs.

Monochromatic LED light sources using WPI patented technology eliminate the need for complex and expensive white light sources and filter wheels. Because the LED modules can be pulsed, sampling frequencies up to 1,000 cycles per second are possible.



Unique fiber optic coupling probe allows for highly efficient transfer of light and ease of placement. Custom probes fit your existing systems.

The LED light source emits specific excitation frequencies which travel through the probe. The excitation light can be comprised of any wavelength of light for which an LED module is available. The probe returns a single emission output to one or two photomultiplier inputs on the front of the **SI-BF100**, which are independently filtered for specific wavelengths. This design allows you to monitor multiple wavelengths from a single emission output.

The LED light source in the WPI design makes this ratiometric fluorometer more compact, energy efficient and affordable. As added benefits, the low-power light source produces much less heat, and it warms up in less than one minute!

This incredible design is not limited to calcium imaging either. By simply replacing the 510nm emission filters in front of the photomultipliers with the desired wavelength filters, your **SI-BF100** becomes a general purpose fluorometer for any application you can imagine. Changing a filter involves removing the two screws that hold the filter carriage on the face of the **SI-BF100**, swapping the filter and reinstalling the integral SMA/filter carriage.

SI-BF-100	Biofluorometer
OPTIONAL COMPONENTS	
M3301	Manual Manipulator for securing the probe
M10	Magnetic Base

SI-BF100 SPECIFICATIONS

CALL FOR APPLICATION

FIBER OPTIC LIGHT INPUT/OUTPUT	SMA terminated
BANDWIDTH	1000 ratios/second
RATIO NOISE	< 0.1 peak to peak
ANALOG OUTPUT RANGE	0–10V (continuous, equivalent to a ratio 0–10)
ANALOG OUTPUT IMPEDANCE	100W
POWER	12VDC, 0.5A, (universal power supply, 110/240VAC)
WARM UP TIME	<1 minute
DIMENSIONS	3.5"H x 17"W x 13"D (88 x 431 x 330 mm)