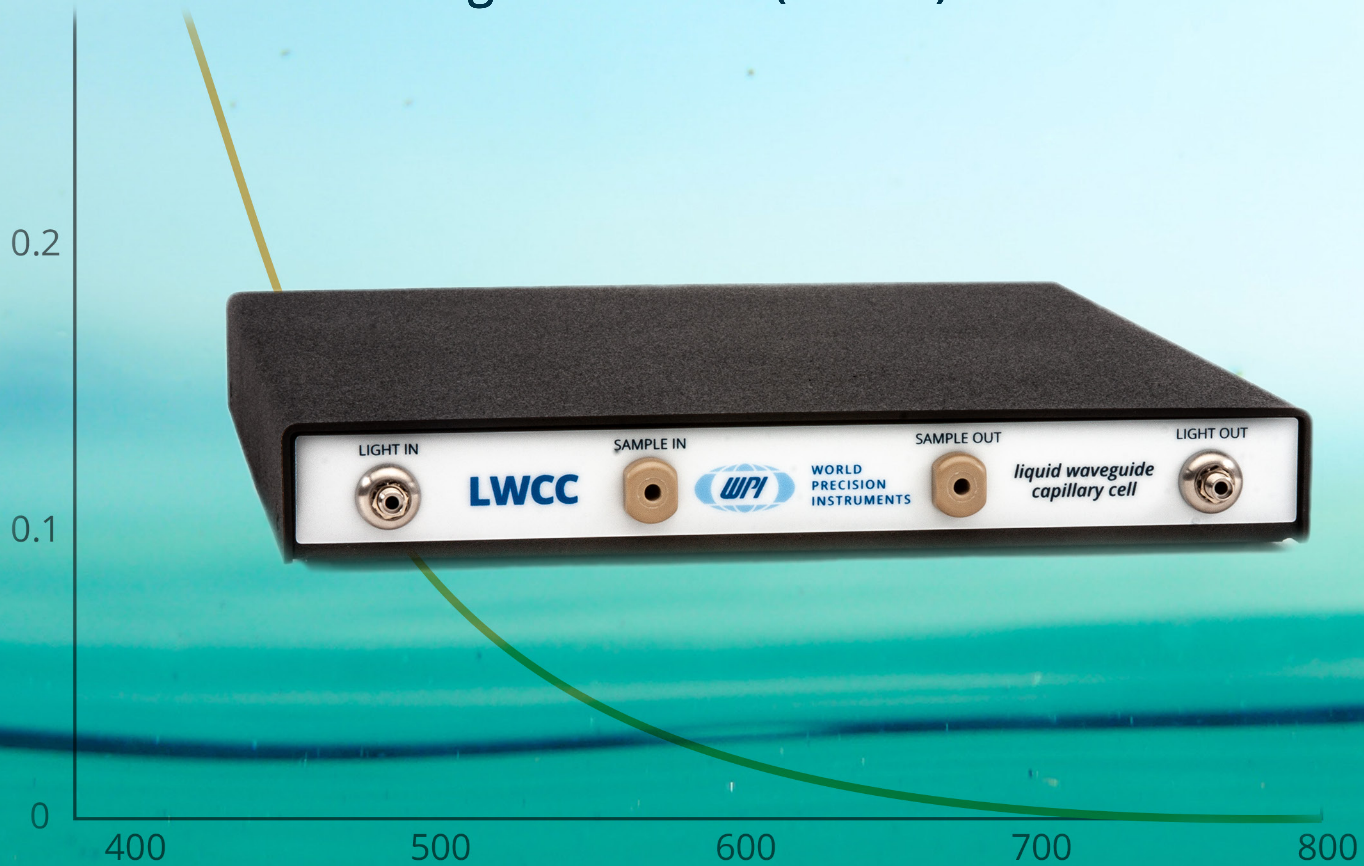
WORLD
PRECISION
INSTRUMENTS

MEASURE

Colored Dissolved Organic Matter (CDOM)



Liquid Waveguide Capillary Cell (LWCC) for aquatic ecosystems

- Detect lower concentrations of solutes
- Conduct a broader range of absorbance measurement

What is CDOM?

Colored Dissolved Organic Matter (CDOM) is organic matter whose optical properties are measurable using WPI's Liquid Waveguide Capillary Cell (LWCC). CDOM occurs naturally in water systems and is derived from organic tannins. CDOM concentration depends on the location where samples are taken, with coastal waters showing higher CDOM concentrations compared to open-ocean waters. In addition, CDOM absorption depends on open-ocean water depth.

Why is the study of CDOM levels important?

CDOM is naturally occurring but the environment can influence the level of CDOM in the water. Measuring the level of CDOM can have a signicant effect on biological activity in aquitic systems. For example, a higher concentration of CDOM in water reduces photosynthesis and can negatively affects the food chain.

Why use WPI's LWCC over traditional spectroscopy systems?

TECHNOLOGY

LWCCs are fiber optic flow cells that combine an increased optical pathlength (1–500 cm) with small sample volumes ranging from 2.4 µL to about 3mL.

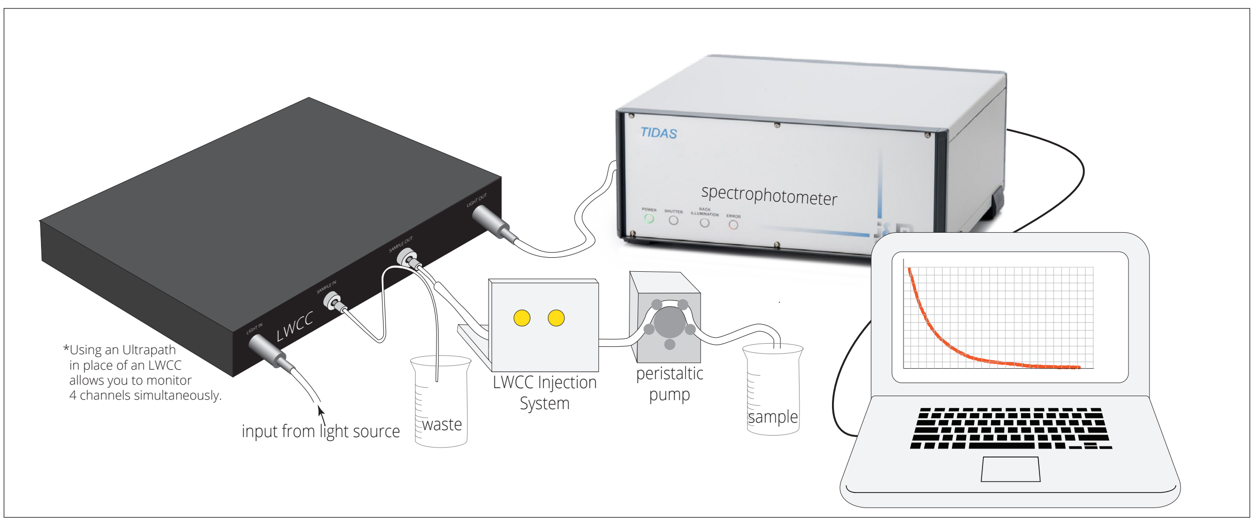
KEY FEATURES

Select models:

- 10–250 cm pathlength (depending on LWCC model)
- 0.31–3.1 mL internal volume (depending on LWCC model)
- Up to 230–730 nm wavelength range (depending on LWCC model)

All models:

- 5–500 fold sensitivity improvement in comparison to 1 cm cuvettes
- 0.55 mm ID for low sample volume sampling
- 2 mm ID for unfiltered liquid samples
- SMA 905 fiber optic connections



Benefits

- Improved dynamic range for broader range of absorbance measurements
- Improved sensitivity of measurement
- Detect lower concentrations of solutes
- Measurements can be made using smaller sample volumes
- Compact, portable system for real time measurement on board a ship

Determining LWCC pathlength

Selecting the proper equipment is imperative when setting up your system. Here are a few considerations:

- Select the LWCC pathlength based on the desired absorption range. Here some reference values for different water types:
  - Fresh water with absorption range > 4.0 m^{-1}
  - Coastal-ocean waters with absorption range 1.0–4.0 m^{-1}
  - Open ocean water with absorption range < 1.0 m^{-1}
- Select the usable internal volume.

Now, you can select components to complete your CDOM analysis system, depending on the selected LWCC.

LWCC Type	Pathlength (cm)	Noise (mAU)	Absorbance Range (mAU)	Absorption Range (m^{-1})	Internal Volume (mL)
LWCC-4010	10	< 0.1	0.5 - 1400	0.012 - 32.0	0.31
LWCC-4050	50	< 0.2	1.0 - 1400	0.005 - 6.4	1.57
LWCC-4100	100	< 0.5	2.5 - 1400	0.006 - 3.2	3.1
LWCC-3050	50	< 0.1	0.5 - 1400	0.002 - 6.4	0.125
LWCC-3100	100	< 0.2	1.0 - 1400	0.002 - 3.2	0.250
LWCC-3250	250	< 0.5	2.5 - 1400	0.002 - 1.2	0.625

The useful absorption range calculation is based on the absorbance detection limits of the LWCC, considering a wavelength range of 300—700 nm.

The effective pathlength of WPI's LWCC is defined as the equivalent pathlength of the cell, if it is assumed that the LWCC follows strictly the Beer-Lambert law: A = ε x c x L, where A is measured absorbance, ε the molar extinction coefficient, c is concentration and L the effective pathlength.

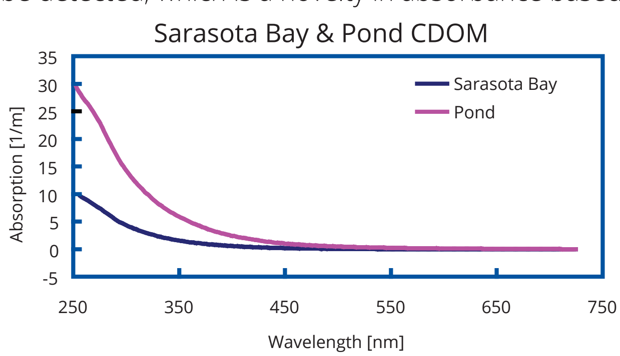
Typically, the longer LWCC pathlength is used to increase the sensitivity when the maximum absorbance values are supposed to be <0.1 AU (Absorbance Unit). Inversely, when absorbance measurements are above 1.4 AU, the LWCC pathlength should be decreased to ensure that measurements still remain within the linear range of the LWCC detection system.

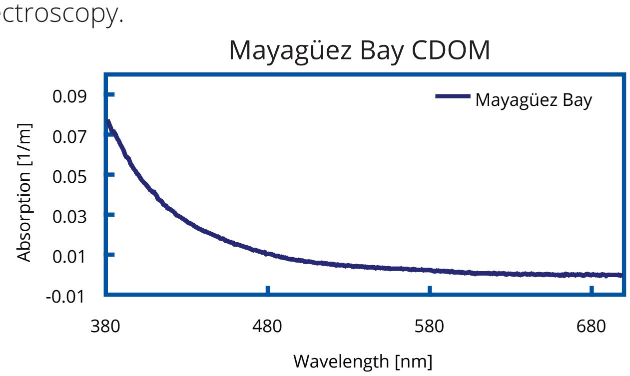
Absorbance measurements obtained with WPI's LWCC and Tidas S300 UV/VIS spectrophotometer are linear up to 1.4 AU. The measured absorbance can be converted to the spectral absorption coefficient α(λ), commonly used in oceanography for CDOM measurements. Absorbance and spectral absorption are related by the formula: α(λ) = 2.303 A (λ) / L, where 2.303 is the conversion factor from decimal to natural logarithmic, A (λ) is the absorbance at wavelength λ and L the LWCC pathlength.

Common applications of CDOM detection

- Determine the biogeochemical cycles, e.g. the organic carbon-based cycle in the ocean.
- Monitor and map surface-water masses.
- Measure the UV light penetration into the ocean to determine:
  - Photosynthesis reaction with effects on phytoplankton population
  - Effect on oceanic food chains
  - Atmospheric oxygen concentration
- Monitor the light absorption of CDOM as it relates to heat storage and the decline of sea ice.

Two typical absorption spectra recorded with an **UltraPath** (**UPUV**) of a seawater and a fresh water sample collected in November 2007 are shown in the figures. Due to their high absorbance, both samples were analyzed in the 10 cm pathlength. The CDOM sample labeled Mayagüez Bay 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.





(Left) 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).

(Right) 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.

System Configurations

Refer to the tables below for selecting the LWCC pathlength.

The CDOM-FRESH System > 4 m⁻¹			
LOW VOLUME		**HIGH VOLUME**	
Product Description	**Item #**	**Product Description**	**Item #**
CDOM-FRESH-LV System Includes:	CDOM-FRESH-LV	**CDOM-FRESH-HV System Includes:**	CDOM-FRESH-HV
LWCC, 50 cm pathlength	LWCC-3050	LWCC, 10 cm pathlength	LWCC-4010
Photo Diode Array (PDA) Spectrophotometer System, UV/VIS (190-720nm), integrated D2H Lamps	505067	PDA Spectrophotometer System, UV/VIS (190-720nm), integrated D2H Lamps	505067
(2) UV-Enhanced Fiber Optic Cables, 1 m, 600 µm Core	WVLUXUVIS-S-600	(2) UV-Enhanced Fiber Optic Cables, 1 m, 600 µm Core.	WVLUXUVIS-S-600
Ministar Peristaltic Pump	504011	PeriStar Pro Pump	PeriPro-4LS
LWCC Injection System	89372	Injector Kit	72100
TTL Control Module for Ministar and/or Peristar	503120	TTL Control Module for Ministar and/or Peristar	503120
UV-Enhanced Fiber Optic Cable	WVLUXUVIS-S-200	UV-Enhanced Fiber Optic Cable	WVLUXUVIS-S-200
(2) SMA Bulkhead feed through Connector/Coupler	13395	(2) SMA Bulkhead feed through Connector/Coupler	13395

The CDOM-COAST System 1-4 m⁻¹			
LOW VOLUME		**HIGH VOLUME**	
Product Description	**Item #**	**Product Description**	**Item #**
CDOM-COAST-LV System Includes:	CDOM-COAST-LV	**CDOM-COAST-HV System Includes:**	CDOM-COAST-HV
LWCC, 100 cm pathlength	LWCC-3100	LWCC, 50 cm pathlength	LWCC-4050
PDA Spectrophotometer System, UV/VIS (190-720nm) with integrated D2H Lamps	505067	PDA Spectrophotometer System, UV/VIS (190-720nm) with integrated D2H Lamps	505067
(2) UV-Enhanced Fiber Optic Cables. 1 m, 600 µm Core.	WVLUXUVIS-S-600	(2) UV-Enhanced Fiber Optic Cables. 1 m, 600 µm Core.	WVLUXUVIS-S-600
Ministar Peristaltic Pump	504011	PeriStar Pro Pump	PeriPro-4LS
LWCC Injection System	89372	Injector Kit	72100
TTL Control Module for Ministar and/or Peristar	503120	TTL Control Module for Ministar and/or Peristar	503120
UV-Enhanced Fiber Optic Cable	WVLUXUVIS-S-200	UV-Enhanced Fiber Optic Cable	WVLUXUVIS-S-200
(2) SMA Bulkhead feed through Connector/Coupler	13395	(2) SMA Bulkhead feed through Connector/Coupler	13395

The CDOM-Ocean System < 1 m⁻¹			
LOW VOLUME		**HIGH VOLUME**	
Product Description	**Item #**	**Product Description**	**Item #**
CDOM-OCEAN-LV System Includes:	CDOM-OCEAN-LV	**CDOM-OCEAN-HV System Includes:**	CDOM-OCEAN-HV
LWCC, 250 cm pathlength	LWCC-3250	LWCC, 100 cm pathlength	LWCC-4100
PDA Spectrophotometer System. UV/VIS (190-720nm) with integrated D2H Lamps	505067	PDA Spectrophotometer System. UV/VIS (190-720nm) with integrated D2H Lamps	505067
(2) UV-Enhanced Fiber Optic Cables. 1 m, 600 µm Core	WVLUXUVIS-S-600	(2) UV-Enhanced Fiber Optic Cables. 1 m, 600 µm Core.	WVLUXUVIS-S-600
Ministar Peristaltic Pump	504011	PeriStar Pro Pump	PeriPro-4LS
LWCC Injection System	89372	Injector Kit	72100
TTL Control Module for Ministar and/or Peristar	503120	TTL Control Module for Ministar and/or Peristar	503120
UV-Enhanced Fiber Optic Cable	WVLUXUVIS-S-200	UV-Enhanced Fiber Optic Cable	WVLUXUVIS-S-200
(2) SMA Bulkhead feed through Connector/Coupler	13395	(2) SMA Bulkhead feed through Connector/Coupler	13395

WORLD PRECISION INSTRUMENTS

USA: International Trade Center, 175 Sarasota Center Boulevard, Sarasota FL 34240-9258 USA
Tel: (941) 371-1003 • **Fax:** (941) 377-5428 • **E-mail:** wpi@wpiinc.com • **Internet:** www.wpiinc.com

UK: 1 Hunting Gate, Hitchin, Hertfordshire SG4 0TJ England • Tel: 44 (0)1462 424700 • E-mail: wpiuk@wpi-europe.com
Germany: Saarstraße 23, D-61169 Friedberg (Hesson) • Tel: +49 (0)6031 1602171 • Fax: +49 (0)6031 1602180 • E-mail: wpide@wpi-europe.com
China & Hong Kong: Rm 18A, No8 Donfang Rd., Pudong District, Shanghai 200120 PRC • Tel: +86 688 85517 • E-mail: ChinaSales@china.wpiinc.com
Brazil: Conselheiro Nabias, 756 sala2611, Santos-São Paulo 11045-002 Brazil • E-mail: info@brazil.wpiinc.com