Chelsea Technologies
A SONARDYNE COMPANY

Pollution monitoring using *in situ* fluorometers

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Technical Director, Chelsea Technologies Ltd

Contents

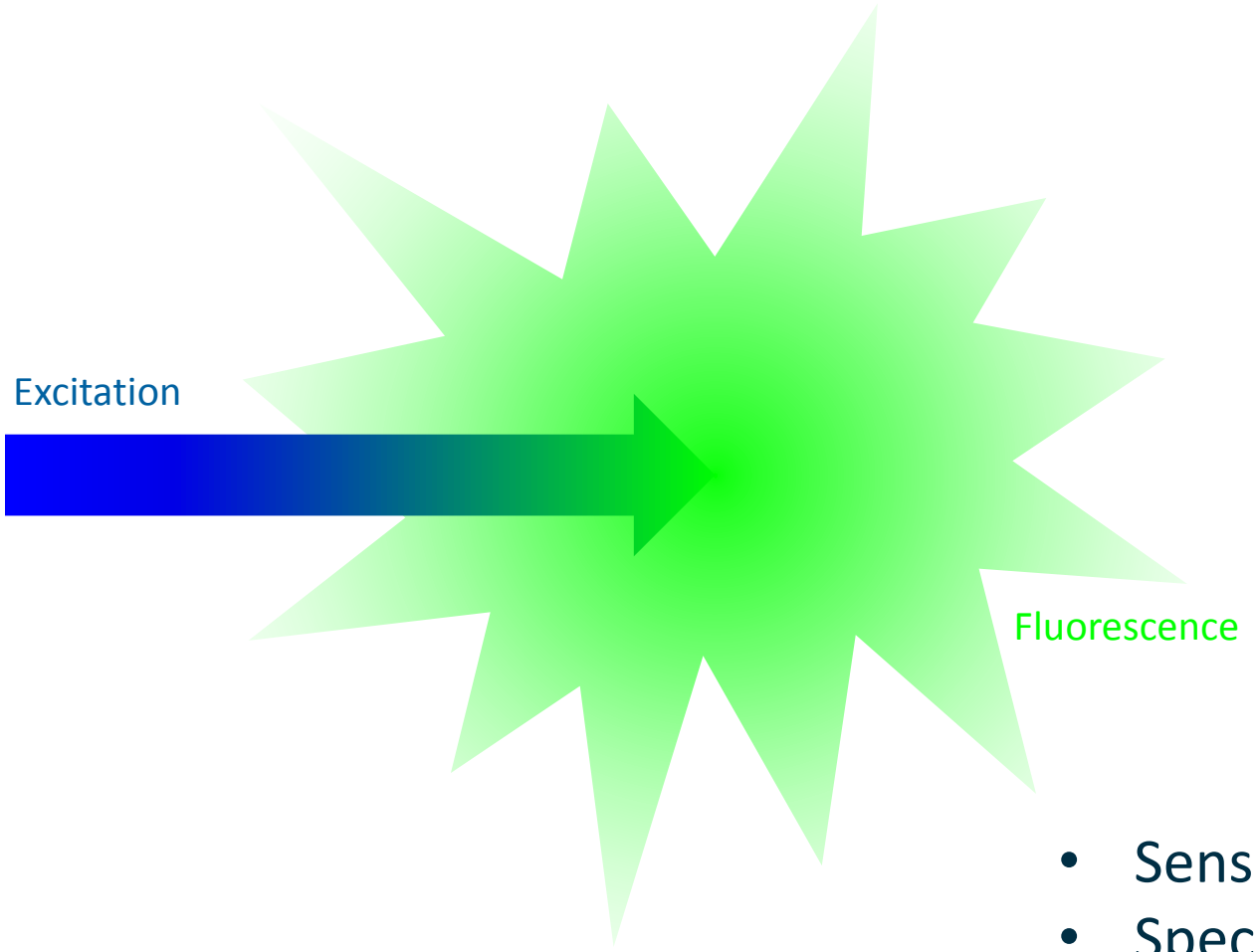
Chelsea Technologies

Business areas

MARINE	DEFENCE	WATER QUALITY	MARITIME/SHIPPING	INDUSTRIAL
				
Oceanographic research	NAD	Fresh water & coastal monitoring	Exhaust gas monitoring	Application of sensor technology
Sensors & systems	Tactical oceanography	Offshore pipeline leak detection	Ballast water monitoring	Process control & monitoring
Acoustic transducers	Acoustic target simulation	Water quality monitoring	FerryBox	Medical diagnostics
Fisheries	CPNI			Agribusiness
	Acoustic ranging systems			

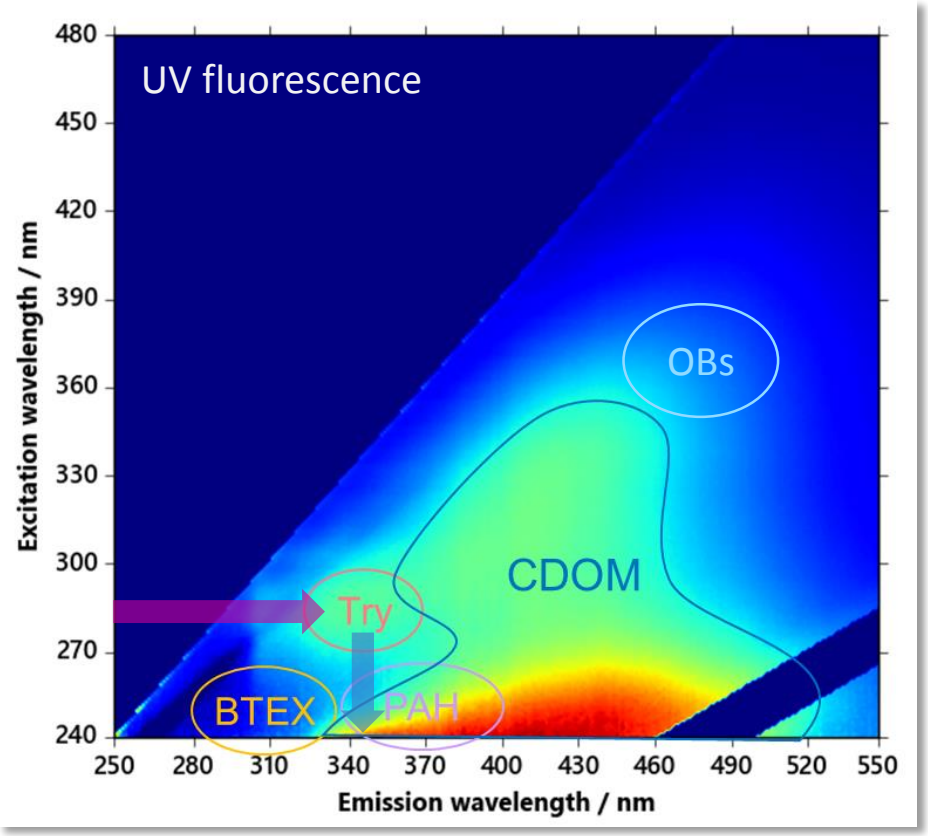
What is fluorescence

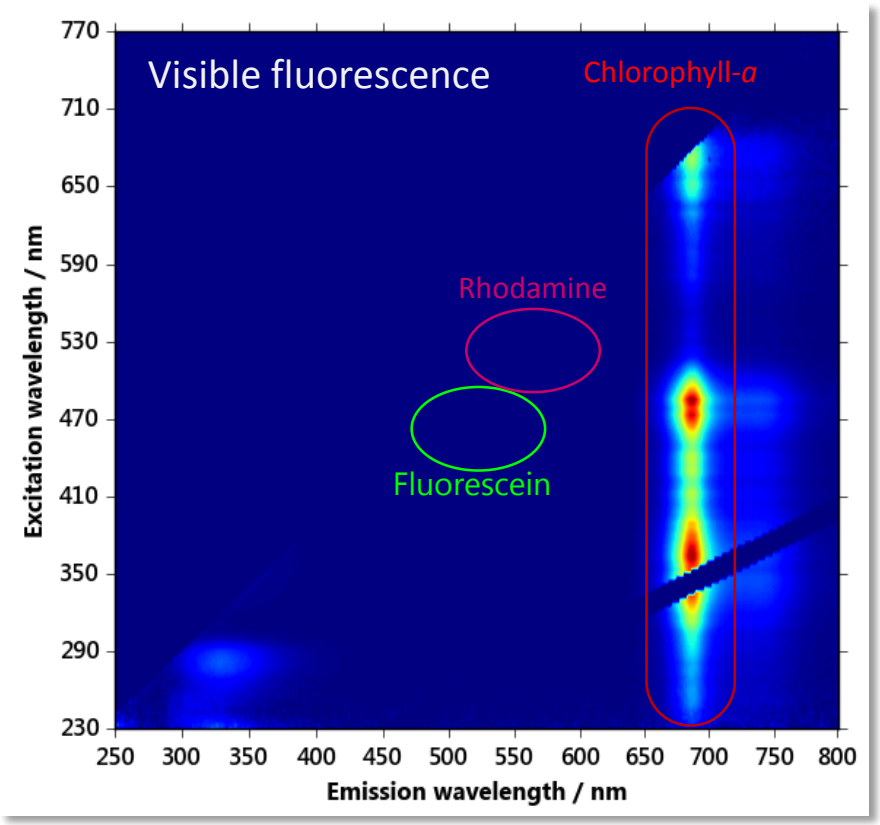
And why measure it?



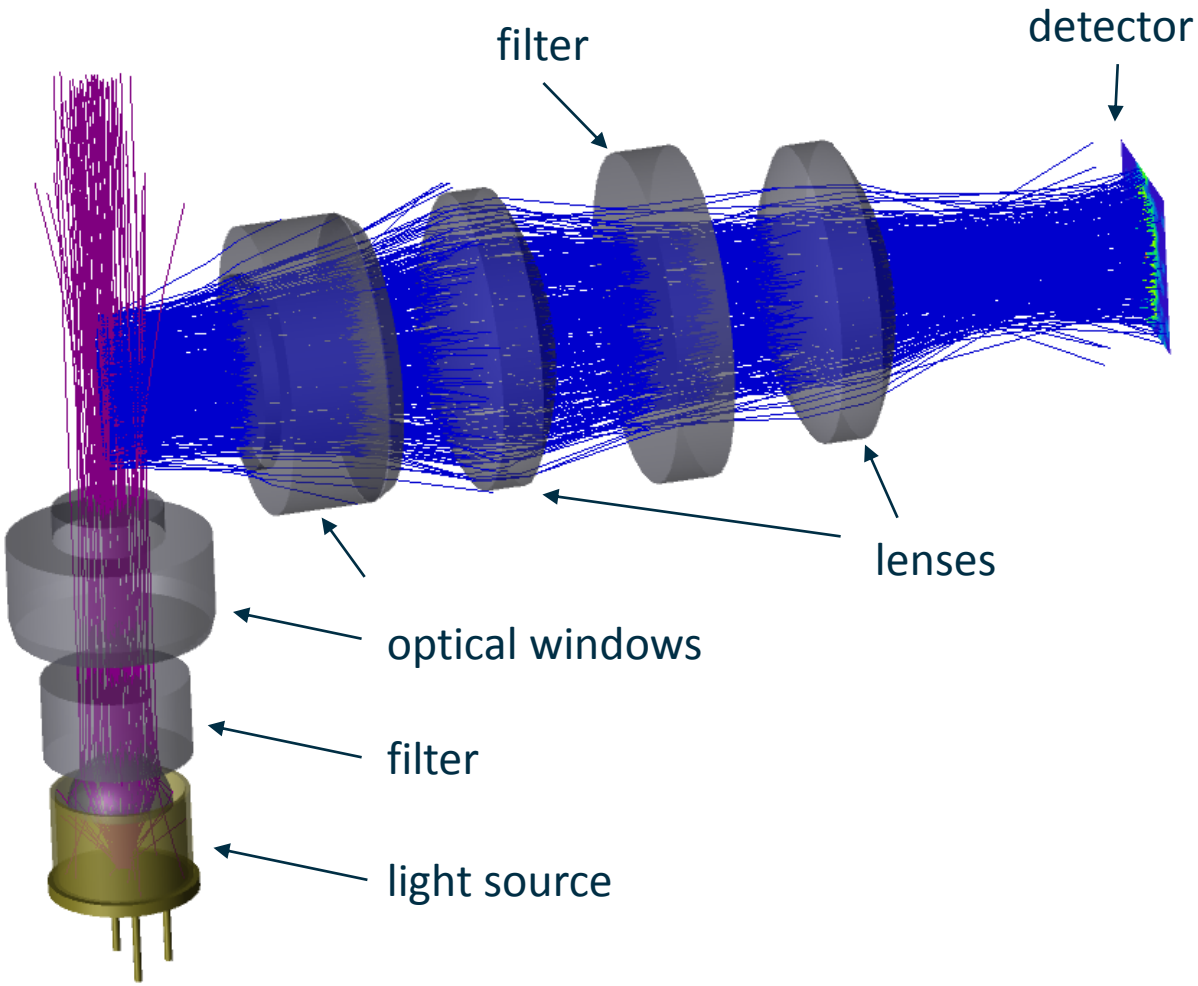
- Sensitivity
- Specificity

Excitation Emission Matrices - EEMs



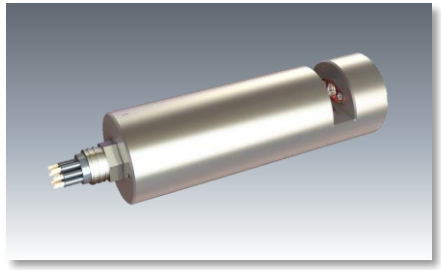


Typical fluorometer design



Chelsea's range of fluorometers

- Visible
  - Algae
  - Dye tracing
- UV
  - Tryptophan
  - Aromatic Hydrocarbons (AH)
  - CDOM
  - Optical brighteners
- Multiparameter
  - AH/CDOM/Chl/Absorbance/Turbidity
  - 4λ Chl/Absorbance/Turbidity
- Active fluorescence
  - Photosynthesis analysis



Chelsea's range of fluorometers

Deployment options

Handheld data logger

Wall mounted data logger

Profiling systems

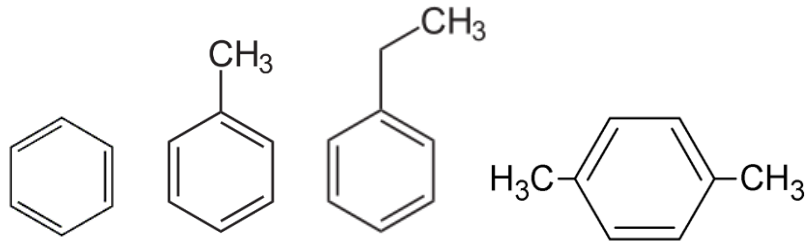
Monitoring cabinets

UV fluorescence

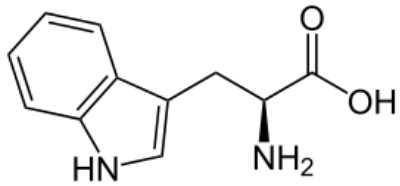
Chelsea has a long history in UV fluorometry

UV fluorometry

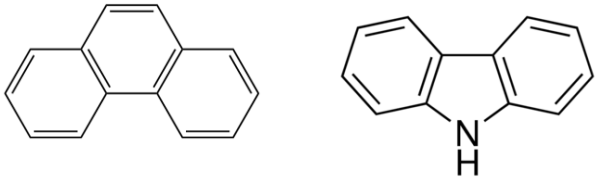
Detectable compounds



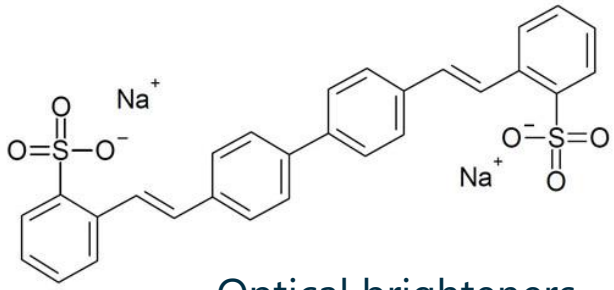
BTEX



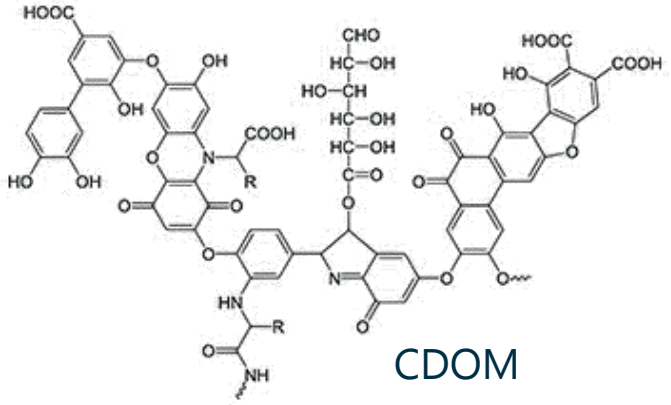
Tryptophan



PAH



Optical brighteners



CDOM

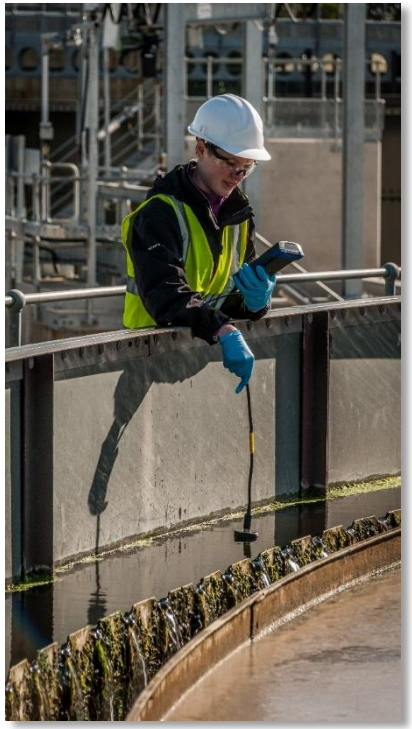
UV fluorometry

Applications

Oil & gas

Wash water

Water quality



Water industry

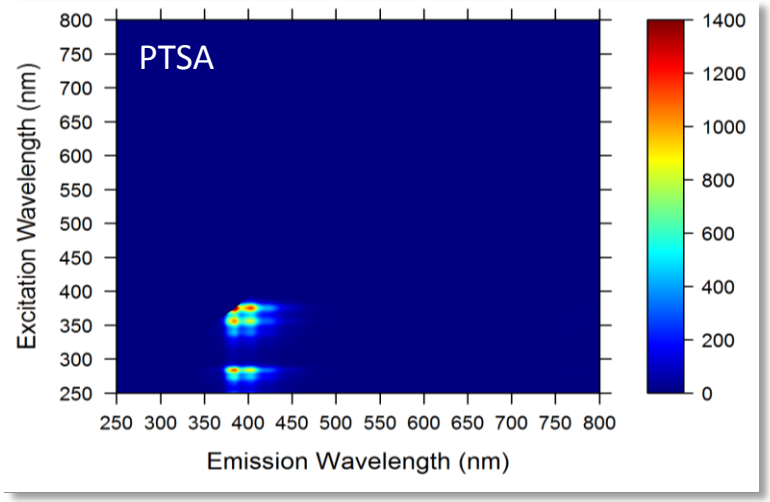
Bathing waters

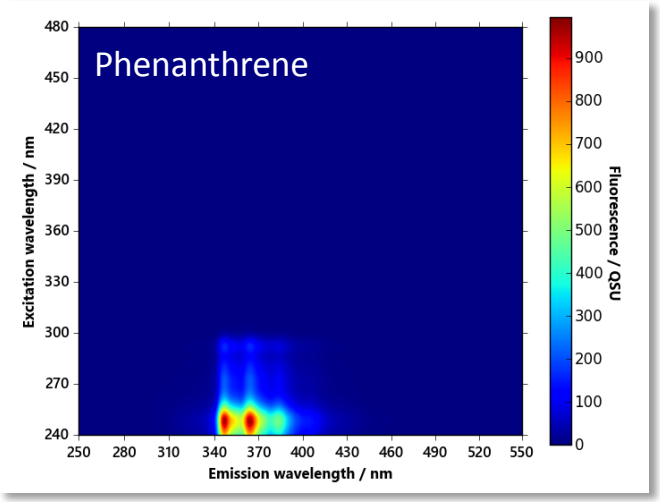
Aviation fuel run-off

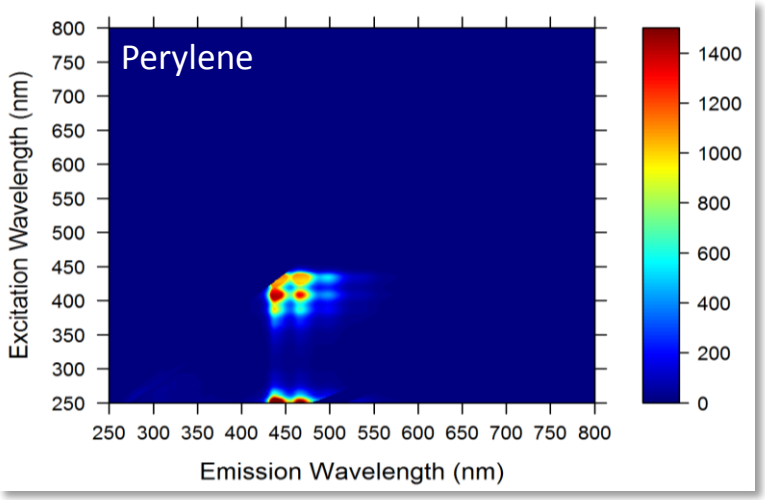
Environmental

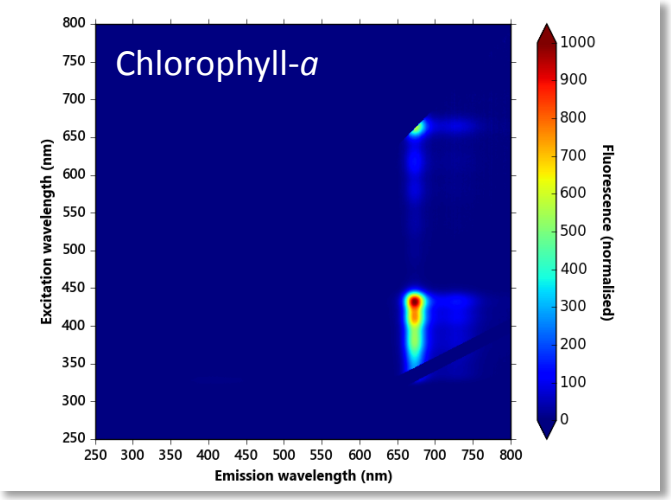
Specificity

Aromatic compounds can have highly structured spectra



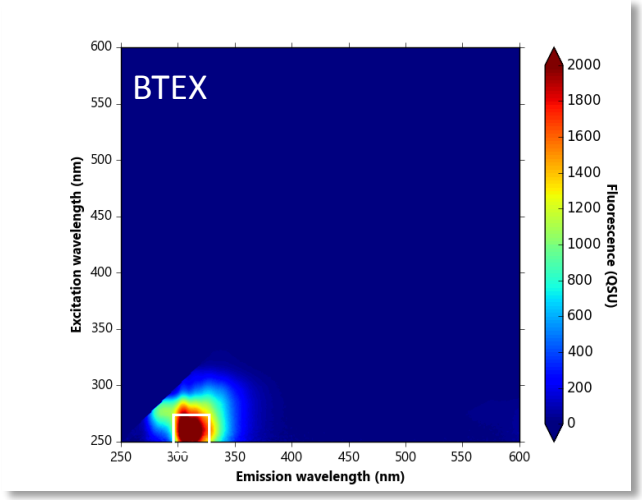


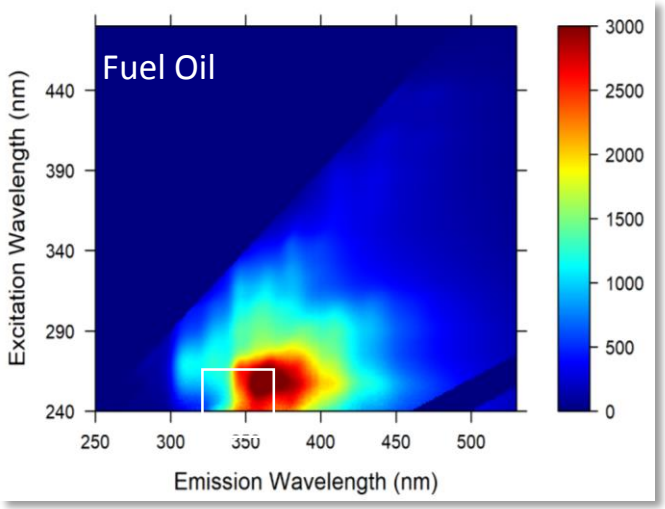


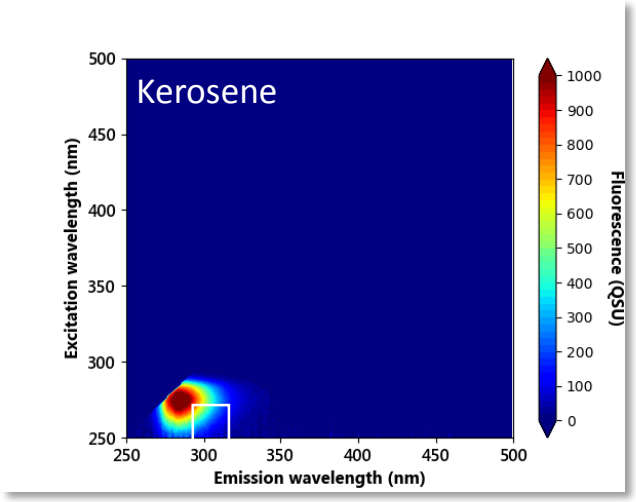


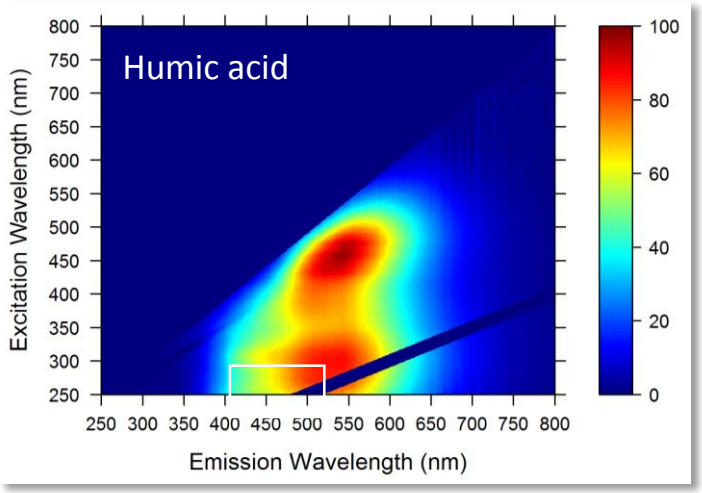
Real world samples

‘cocktail’ of compounds



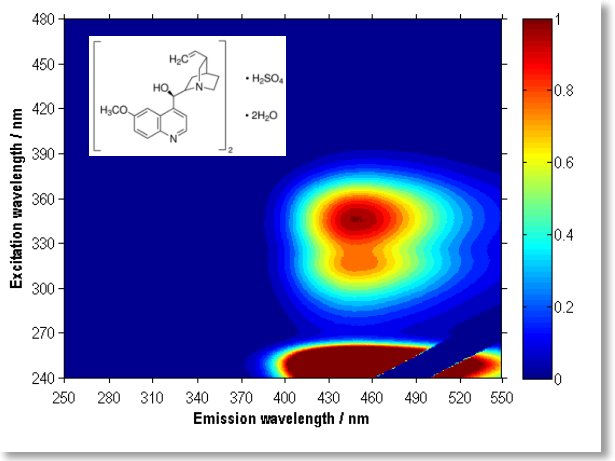




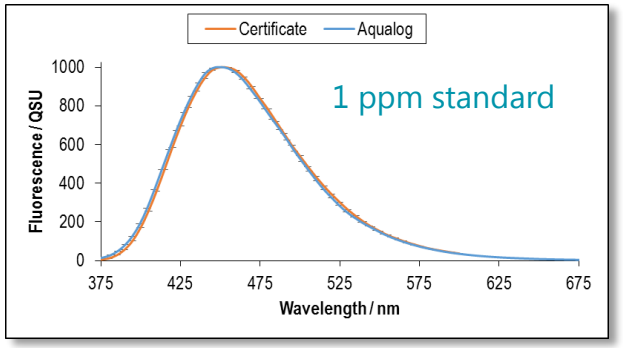


Fluorescence standardization

Essential for fluorescence to be more widely adopted



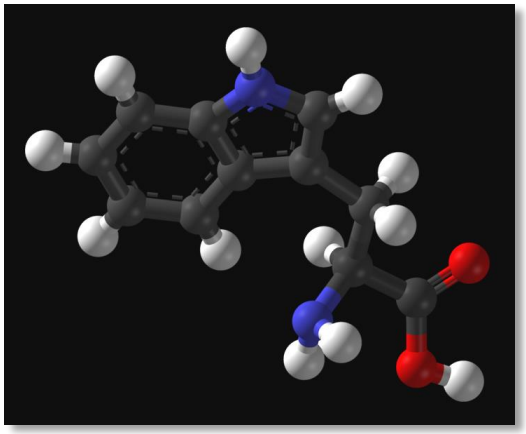
- Quinine Sulphate: NIST-traceable, certified reference material
- Aqualog normalises spectral response for source intensity and detector sensitivity to correlate different calibration solutions
- QSU calibration provides an absolute measurement of fluorescence allowing direct comparison between different sensor configurations

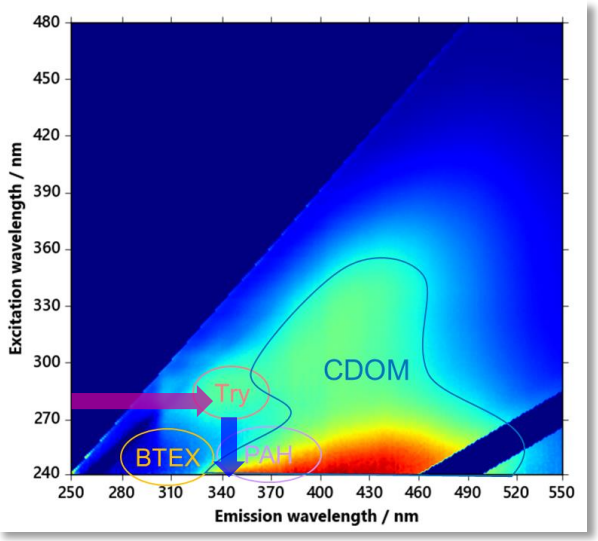


Tryptophan fluorescence

What is it?

- An essential amino acid in human diet
- Main component of protein fluorescence
- Metabolic product in bacteria
  - Sewage & faecal contamination of waste waters
  - Agricultural runoff
  - Bacterial activity
- Has been shown to correlate with:
  - BOD_5
  - Bacterial cell count



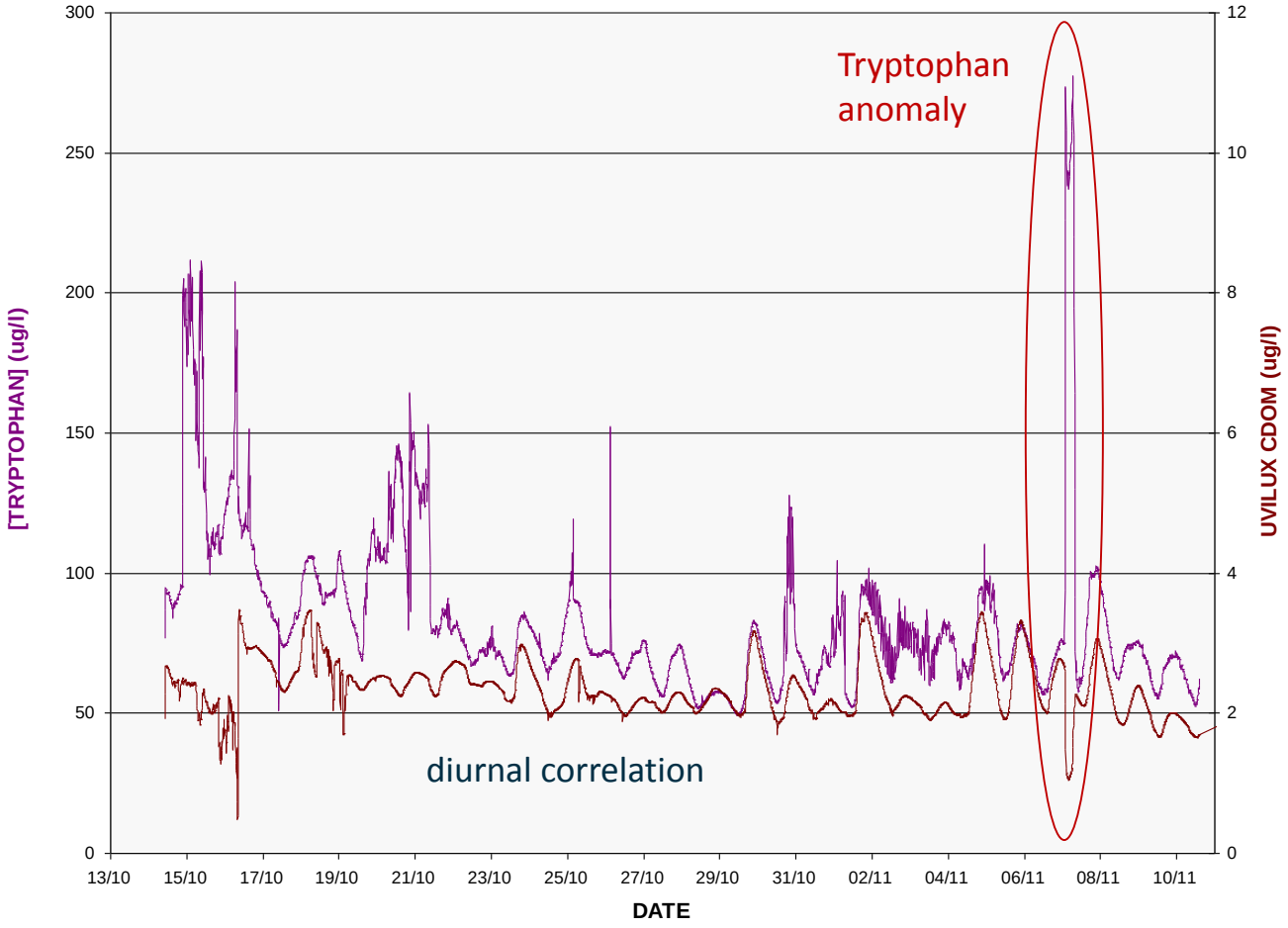


WWTW outflow

Pollution source tracking

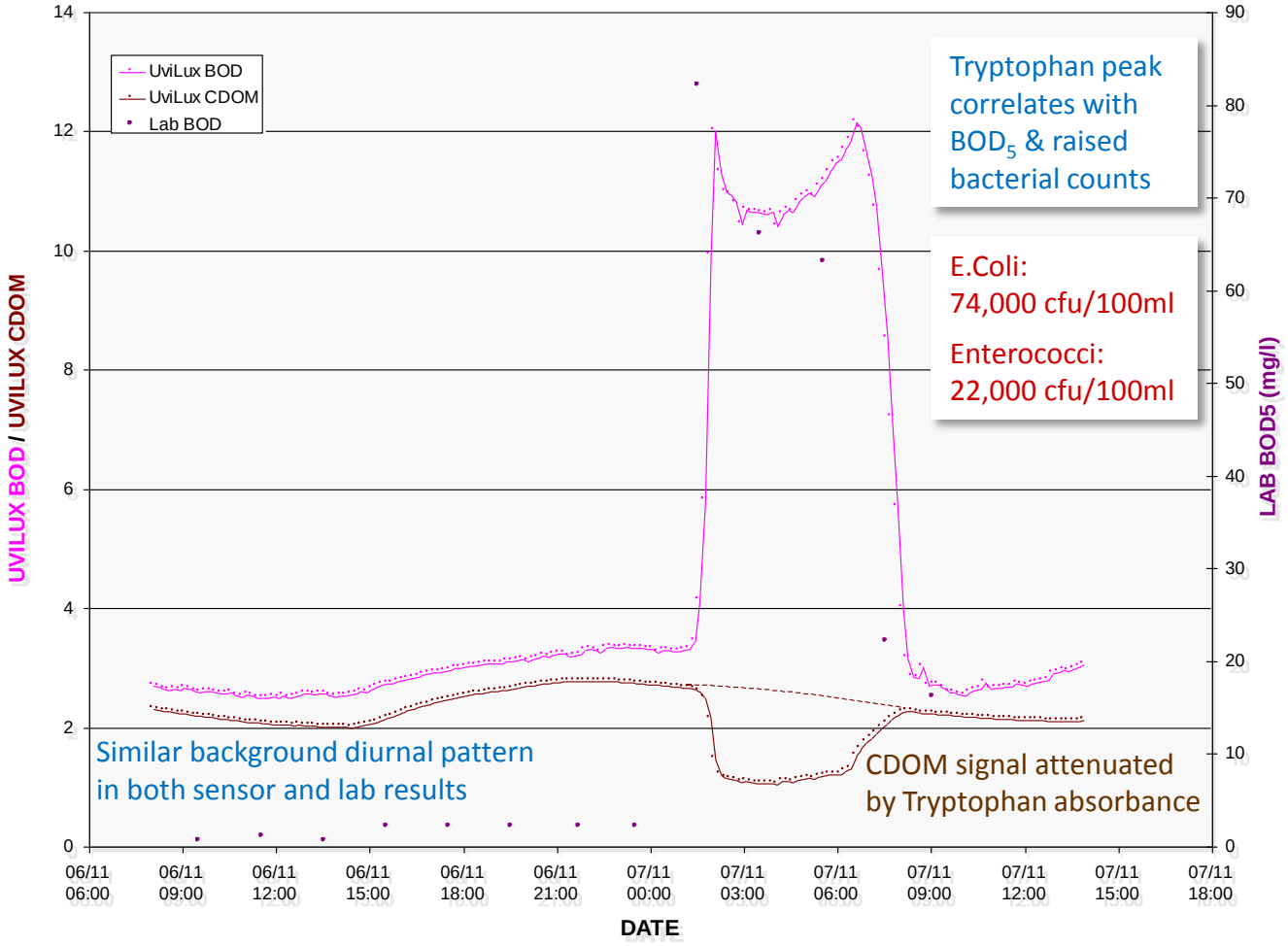
WWTW event detection

Tryptophan and CDOM deployment



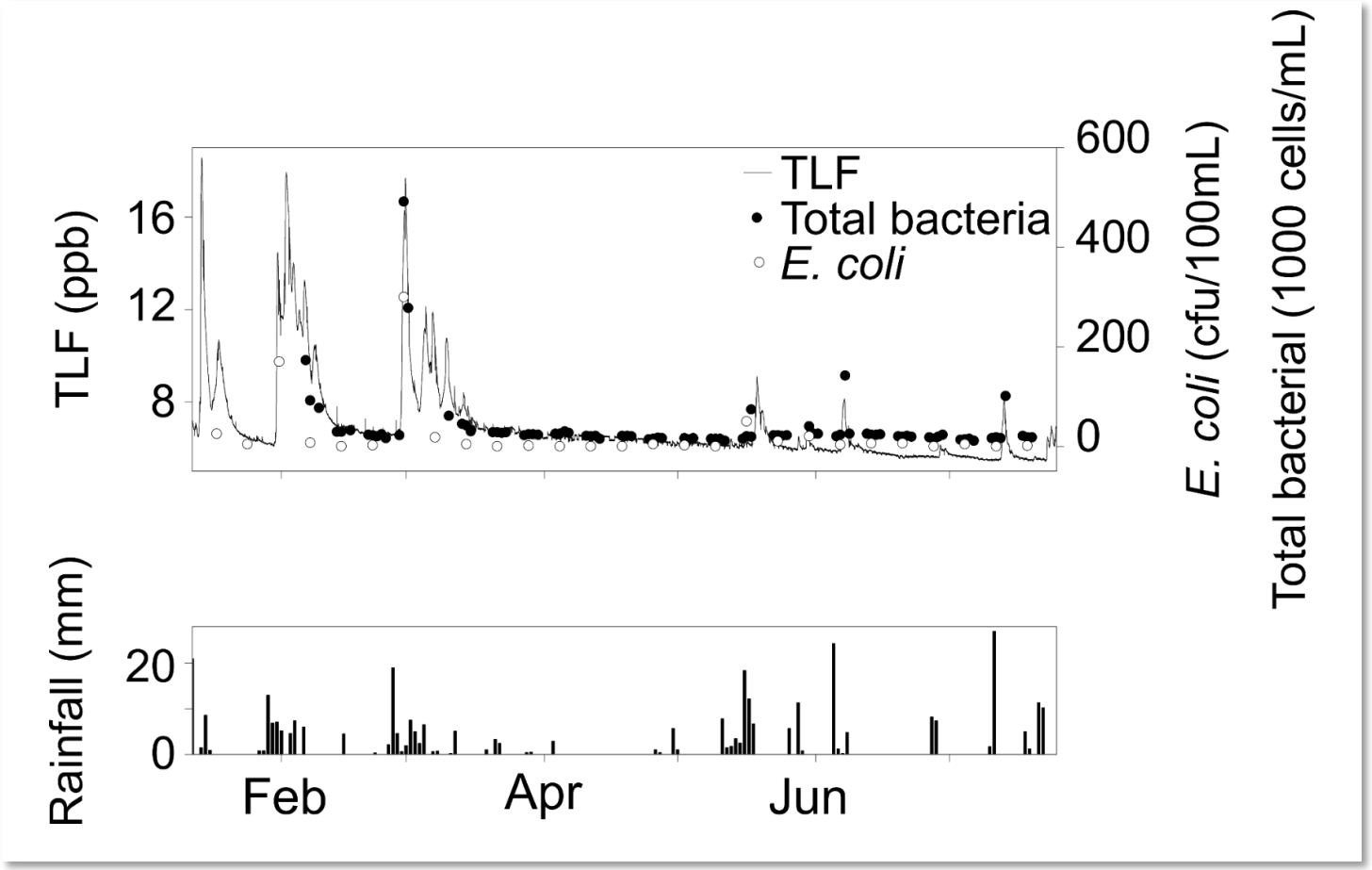
WWTW event detection (cont.)

Benefits of continuous monitoring



Bacterial monitoring in groundwater

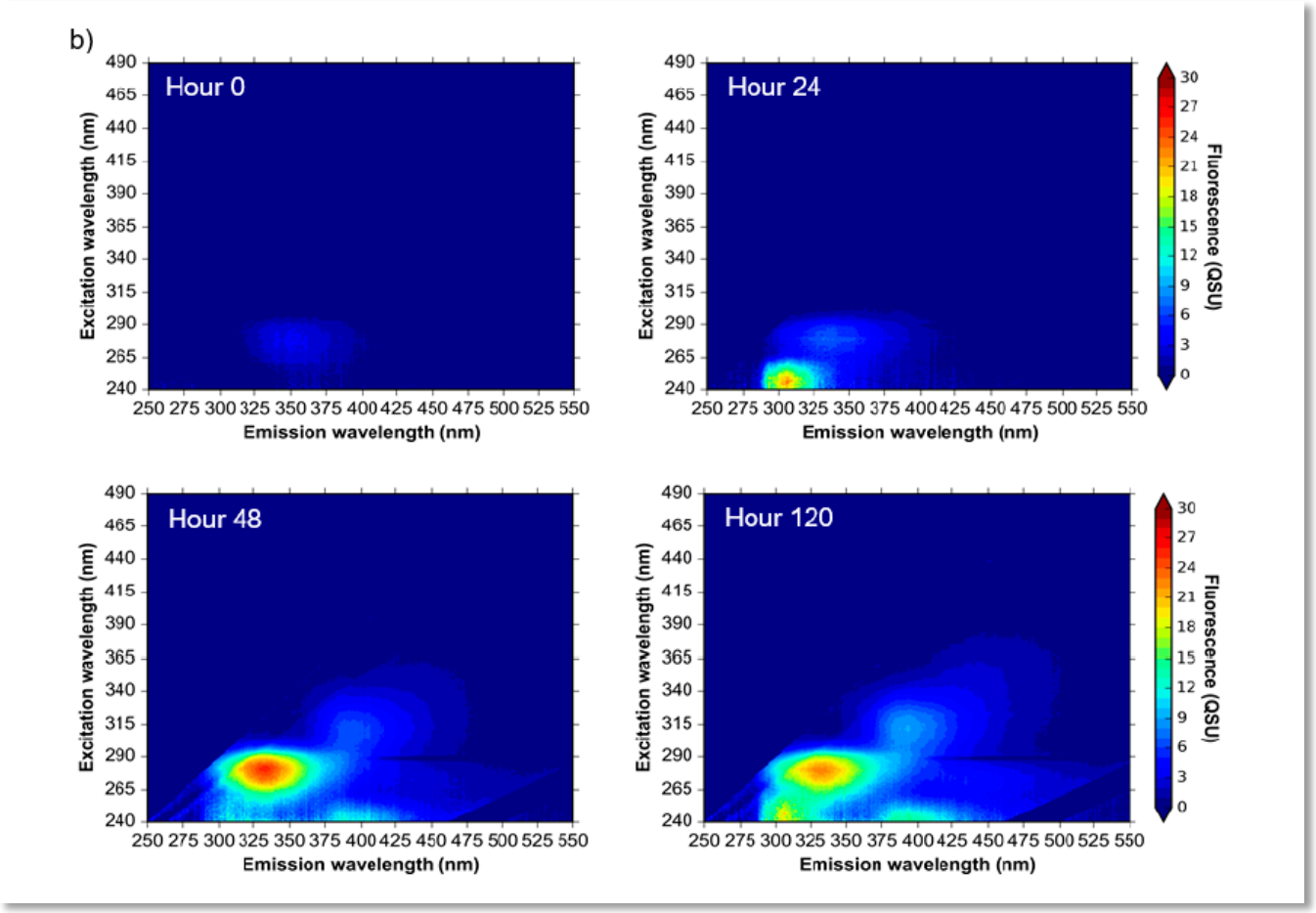
Correlation with bacterial counts



Sorensen, J.P.R., Lapworth, D.J., Marchant, B.P., et al. (2015). In-situ tryptophan-like fluorescence: a real-time indicator of faecal contamination in drinking water supplies. *Water Research*, 81, 38-46.

But what are we measuring?

Tryptophan fluorescence as a function of bacterial growth



Fox B.G. et al, (2019). Microbial Processing and Production of Aquatic Fluorescent Organic Matter in a Model Freshwater System, *Water*, 11, 10; doi:10.3390/w11010010

Indicator of bacterial activity

Tryptophan fluorescence vs cell count

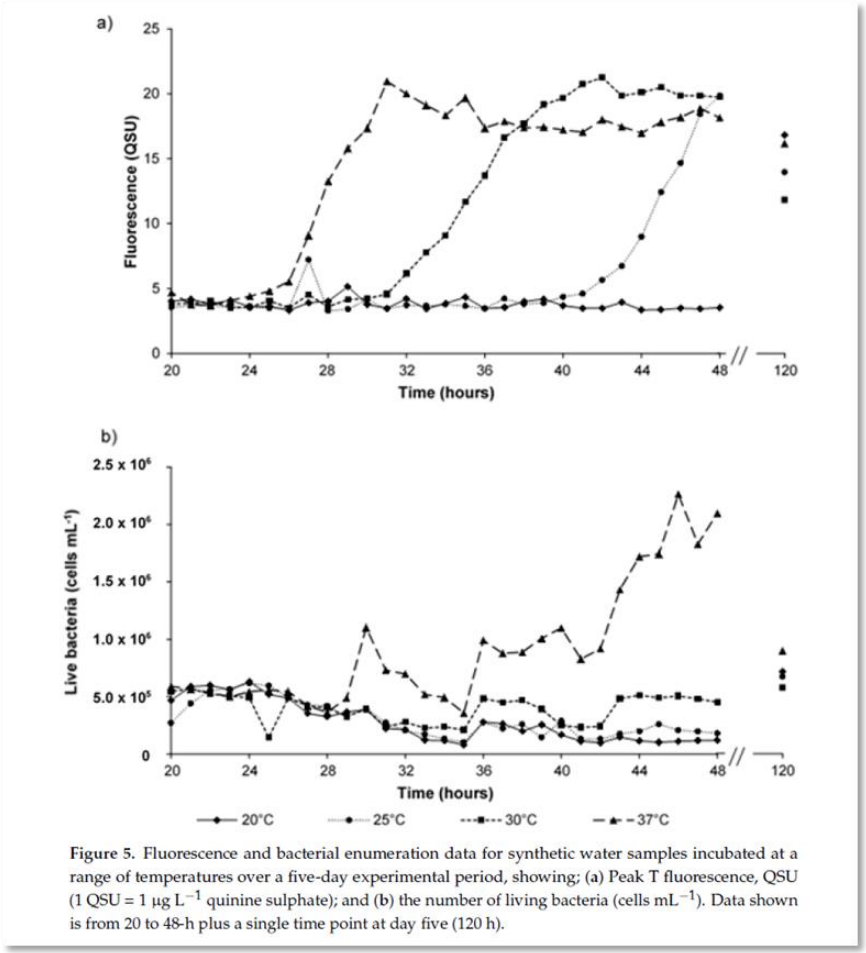
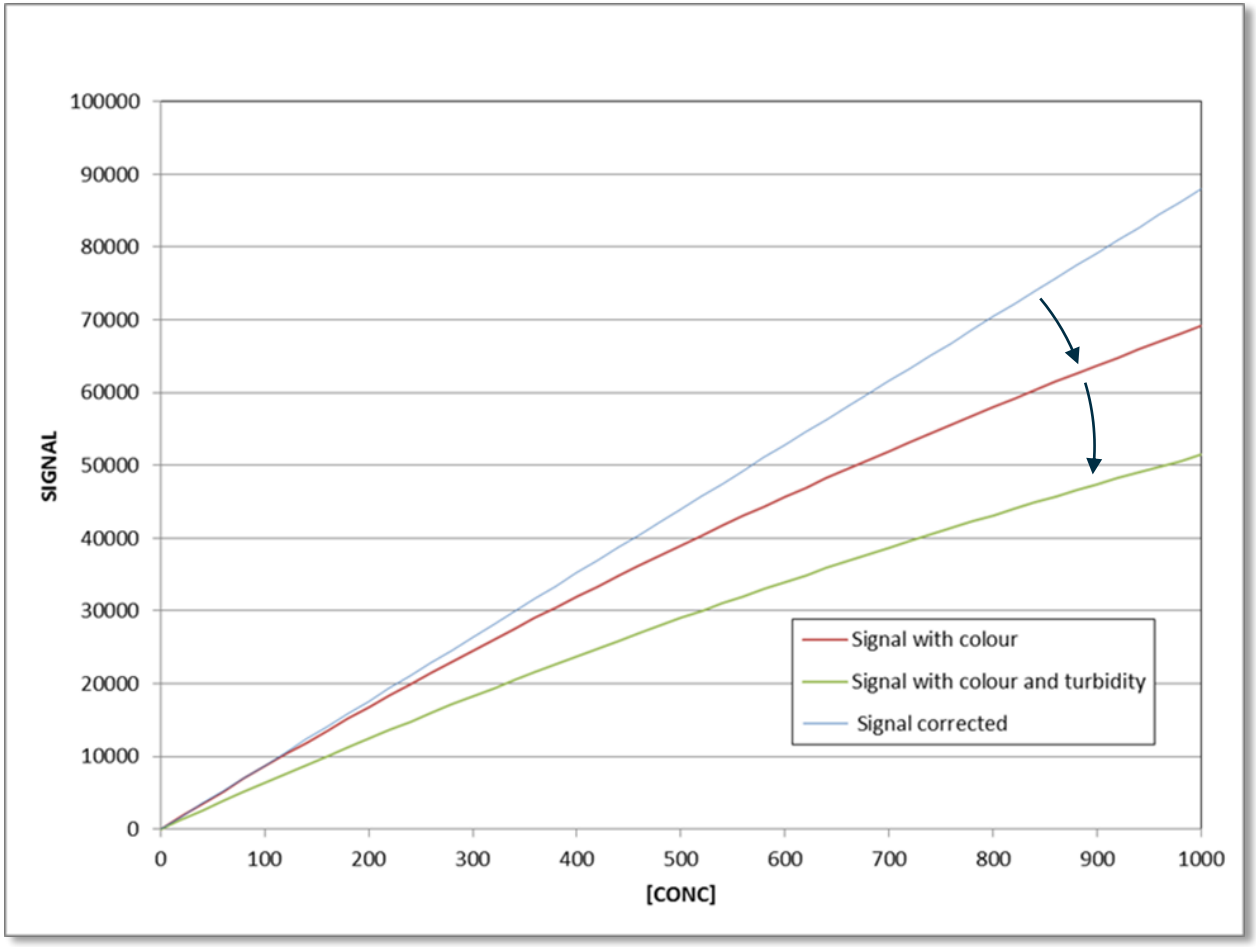


Figure 5. Fluorescence and bacterial enumeration data for synthetic water samples incubated at a range of temperatures over a five-day experimental period, showing; (a) Peak T fluorescence, QSU (1 QSU = 1 μg L^{-1} quinine sulphate); and (b) the number of living bacteria (cells mL^{-1}). Data shown is from 20 to 48-h plus a single time point at day five (120 h).

Fox B.G. et al, (2019). Microbial Processing and Production of Aquatic Fluorescent Organic Matter in a Model Freshwater System, *Water*, 11, 10; doi:10.3390/w11010010

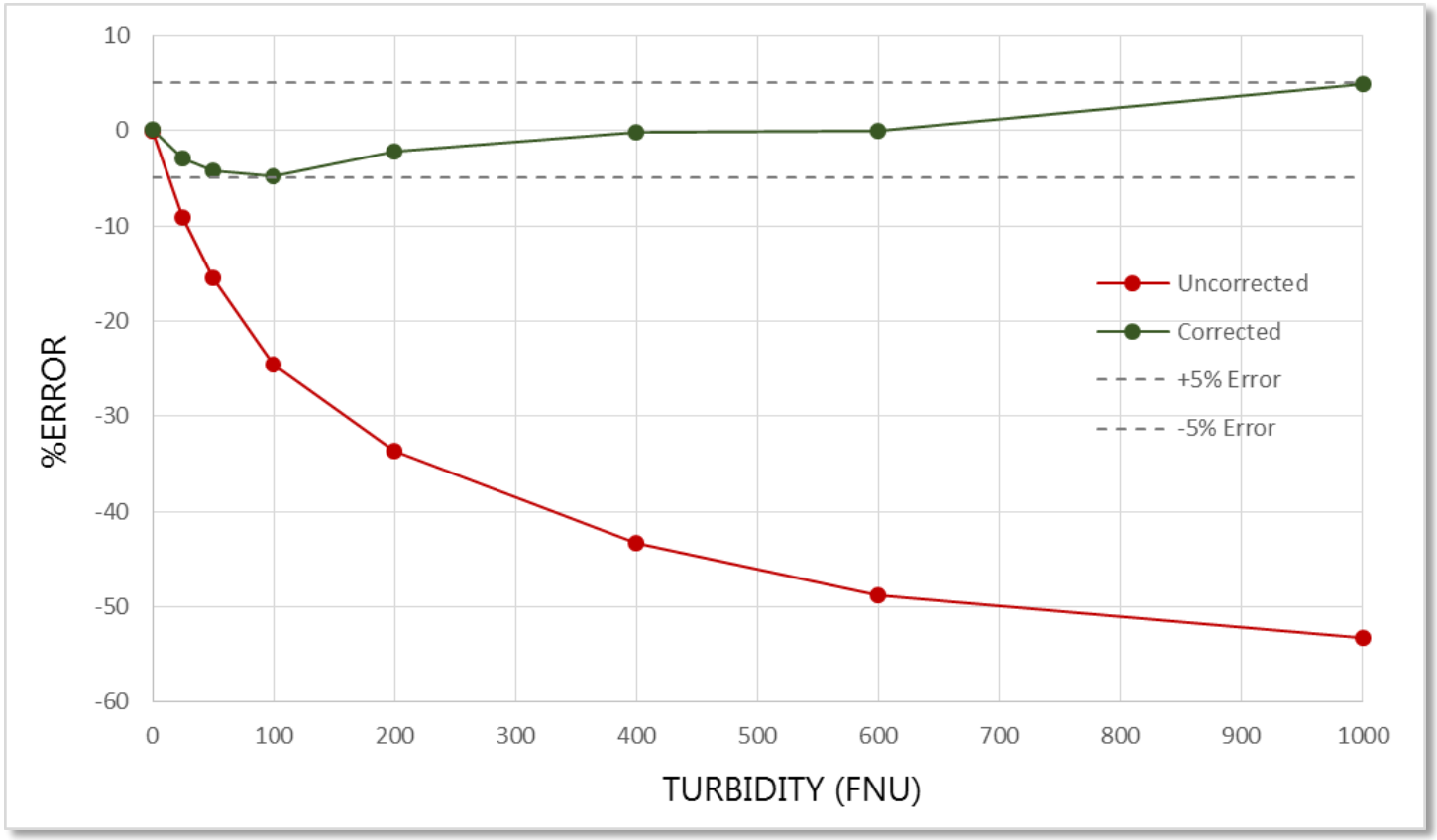
Turbidity & ‘colour’ interference

Both effect must be taken into account



Turbidity & ‘colour’ correction

Correction algorithm development



Effect of Turbidity correction for 270 ug/l phenanthrene
- corrected result is within ±5% from 0-1000 FNU

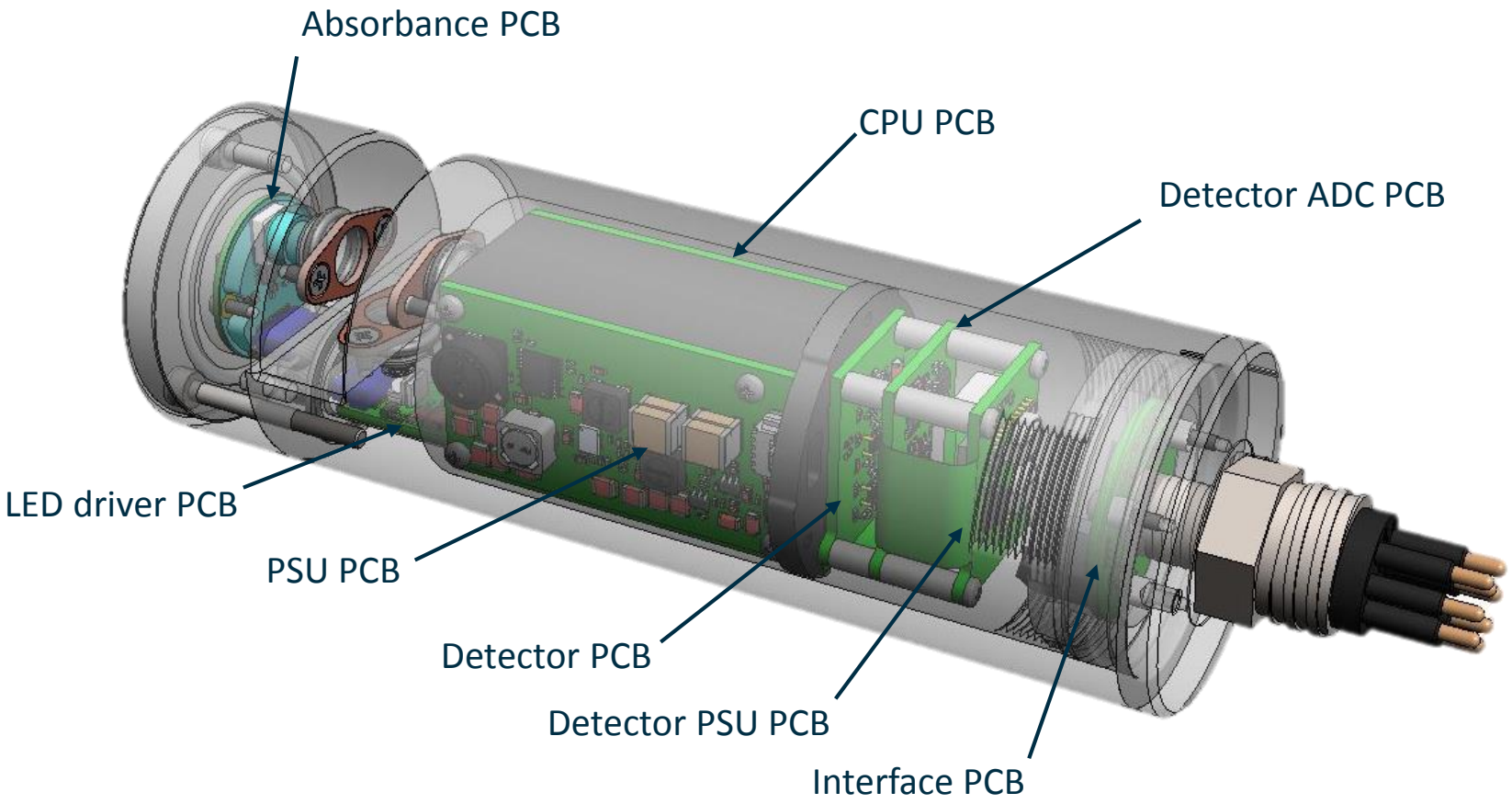
VLux multiparameter ‘sonde’

New approach to *in situ* monitoring

Sense OCEAN

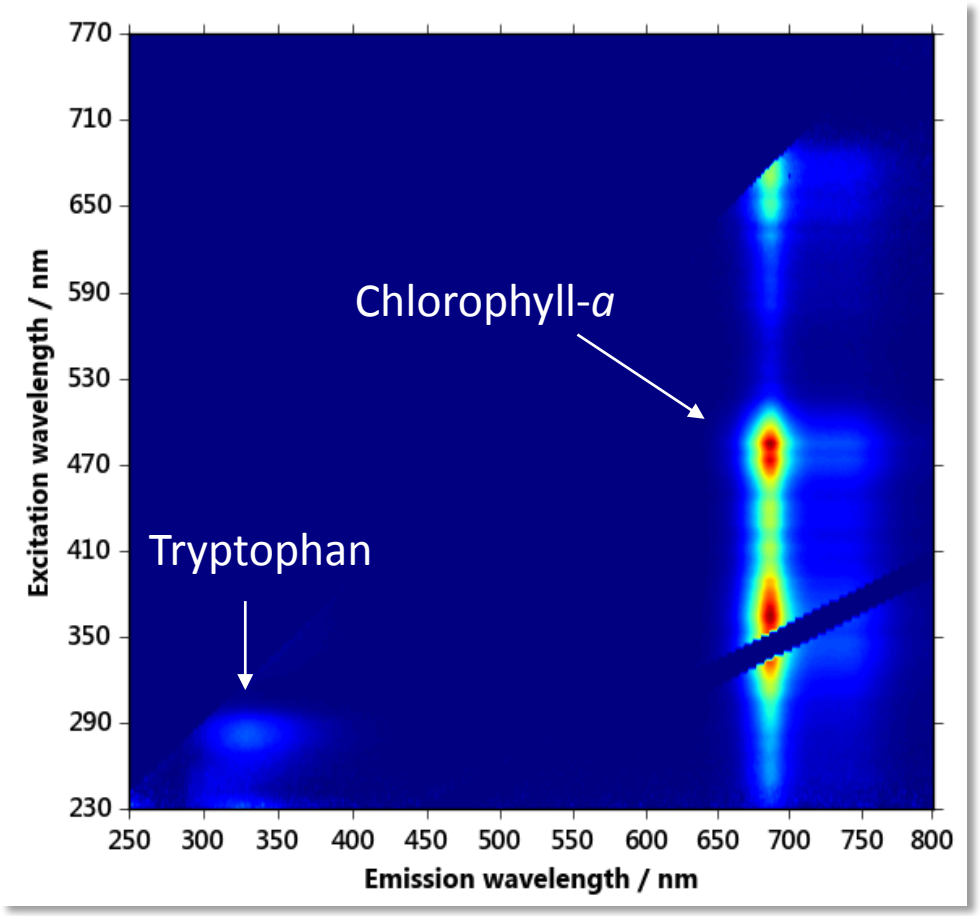
VLux multiparameter ‘sonde’

Electro-optics



VLux multiparameter ‘sonde’

Potential algal interference



VLux multiparameter ‘sonde’

Variants

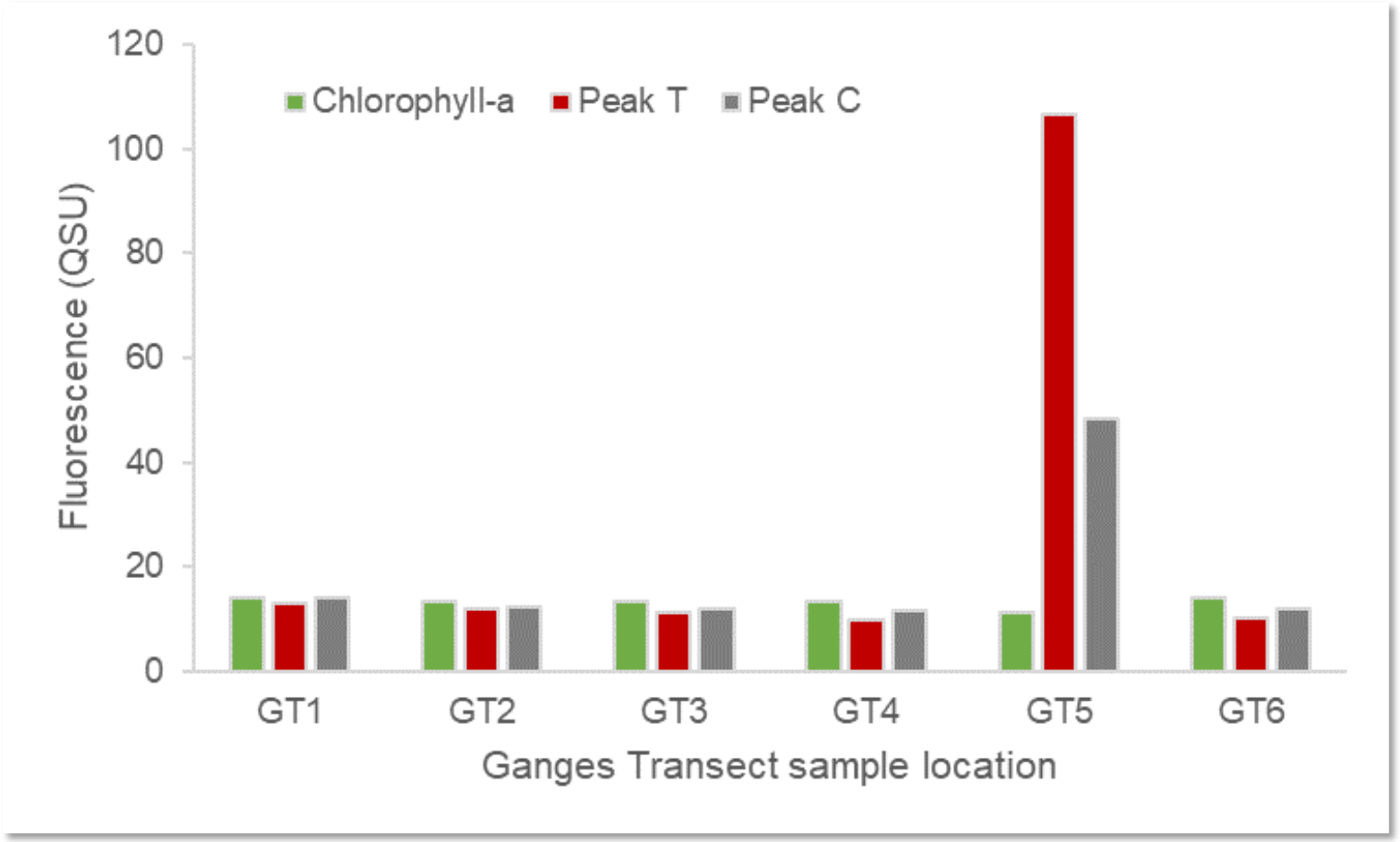
Parameter	V-Lux (BTEX)	V-Lux (PAH)	V-Lux (Tryptophan)	V-Lux (Algae)
BTEX	✓			
PAH		✓		
Tryptophan			✓	
CDOM	✓	✓	✓	
Chlorophyll-a & -c	✓	✓	✓	✓
Chlorophyll-b & -c				✓
Phycoerythrin				✓
Phycocyanin				✓
Absorbance	✓	✓	✓	✓
Turbidity	✓	✓	✓	✓

VLux trial in Kolkata

Ganga tributary transect

VLux trial in Kolkata

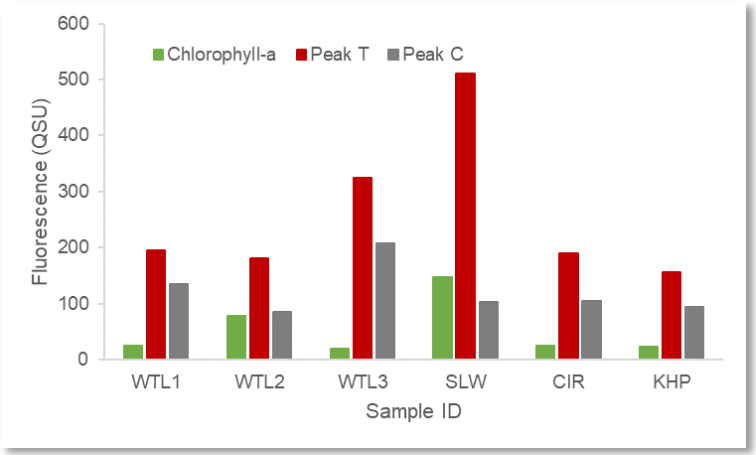
Ganges transect



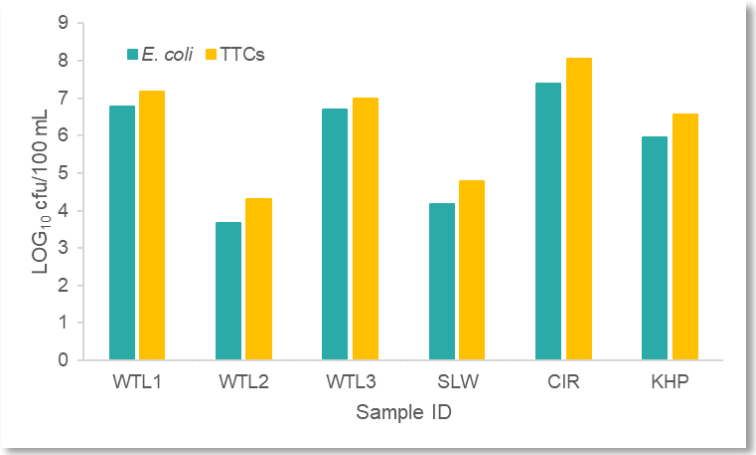
VLux trial in Kolkata

Wetlands and canals

Fluorescence



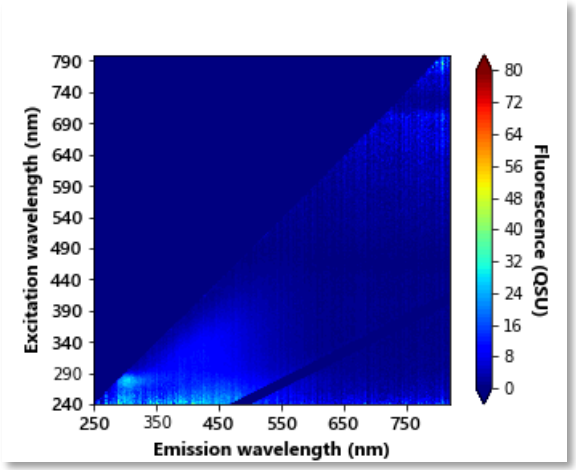
Cell counts



VLux trial in Kolkata

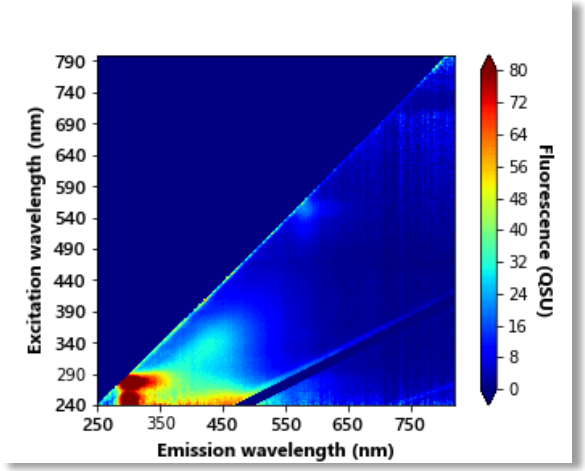
Potential algal bloom interference

Ganges (GT1)



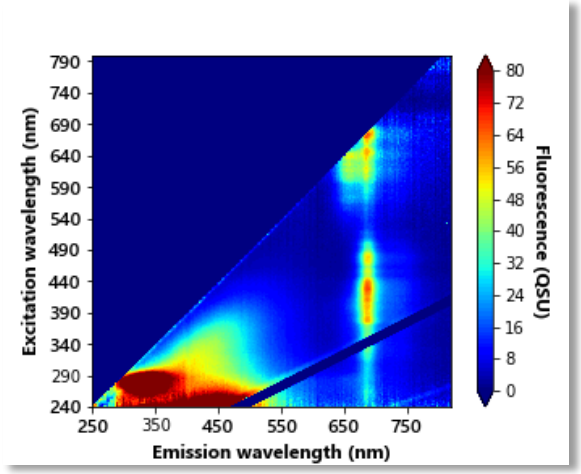
Ganga transect mid-river. No obvious biological pollution source.

Ganges (GT5)



Ganga transect sewage outflow, 100 m bathing area.

Wetlands (WTL2)



Wetlands, ‘clean’ pond overflow. Treated fisheries pond with visible green colouration.

VLux multiparameter ‘BioSonde’

- New multi-parameter fluorometer
  - 3x fluorescence, absorbance, turbidity and temperature channels
  - Turbidity, absorbance and temperature compensation
  - Linear dynamic range extended (x20)
  - Turbidity is ISO 7027:1999(E) compliant
- Long term calibration stability
- Traceable output in relative fluorescence units (QSU)
- Internal logging, range of data output options
- Integrated biofouling protection

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Thank you

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