Development of an Autonomous Sensing Platform for Detection of Nutrients in Natural Waters.

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Insight

Nutrients such as Phosphate, Ammonia, Nitrite and Nitrate are central in any environmental processes, including several microbial, plant and animal metabolic processes. The nutrient platform is based on a combination of microfluidic analytical systems, colorimetric reagent chemistries, low cost LED based optical detection and wireless communications. Each component was developed, assessed and optimised to evaluate the suitability before being integrated to form a working pre-competitive prototype
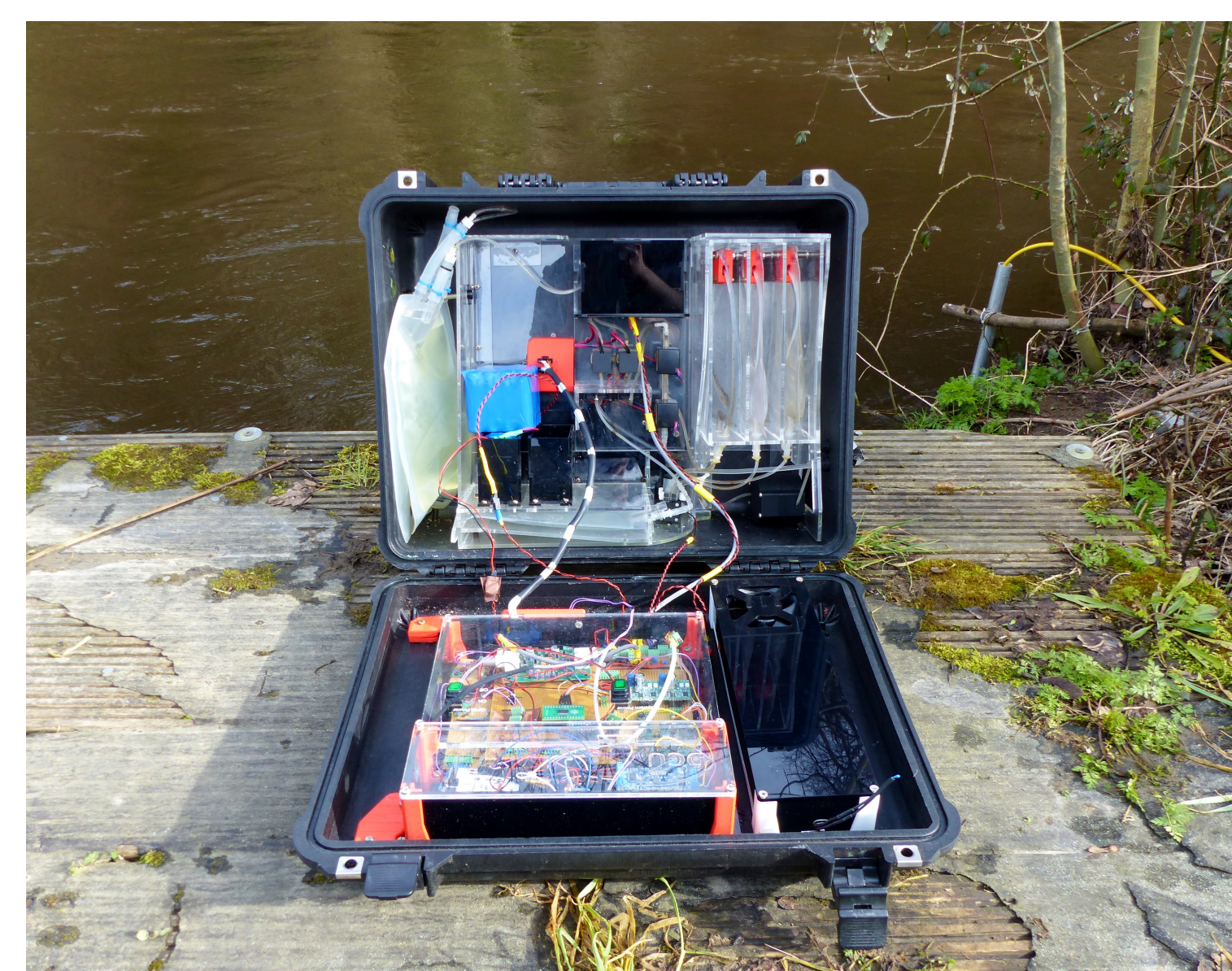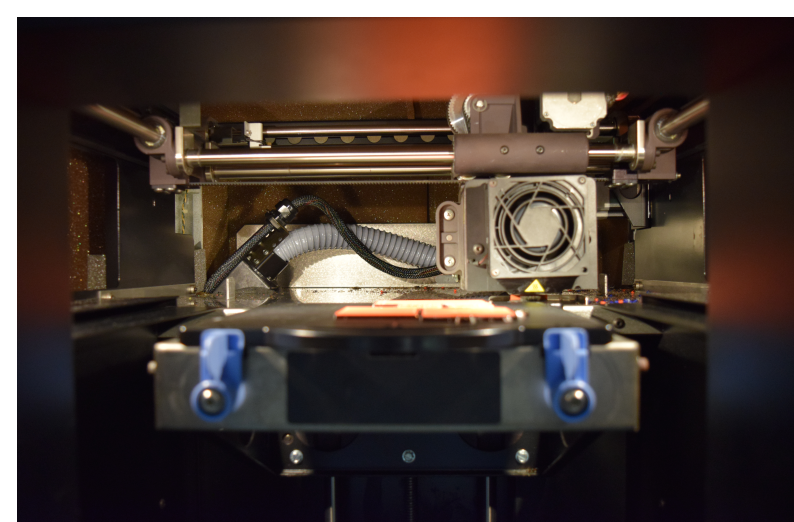

Generation 4 Nutrient Platform

The Generation 4 Nutrient Platform was deployed for 27 days along the River Liffey.

During this deployment a total of 636 measurements were taken. Internal temperature, humidity and pressure measurements were recorded

	Phosphate (PO_4^{3-}) (µM)	Nitrite (NO_2^-) (µM)	Nitrate (NO_3^-) (µM)
LOD	0.05	0.05	0.05

|	Temperature (°C) External	Water Level (cm)	Phosphate (PO_4^{3-}) (µM)
Minimum	-4.5	63	0.1
Maximum	8.8	187	31.2
Average	2.1	115	13.0

Rapid Prototyping

A series of Rapid Prototyping techniques including Laser ablation, 3D printing and precision micro milling are used to fabricate the nutrient platform. The use of these techniques allow for cost effective prototyping with the ability to modify designs in house.

Colorimetric Chemistries
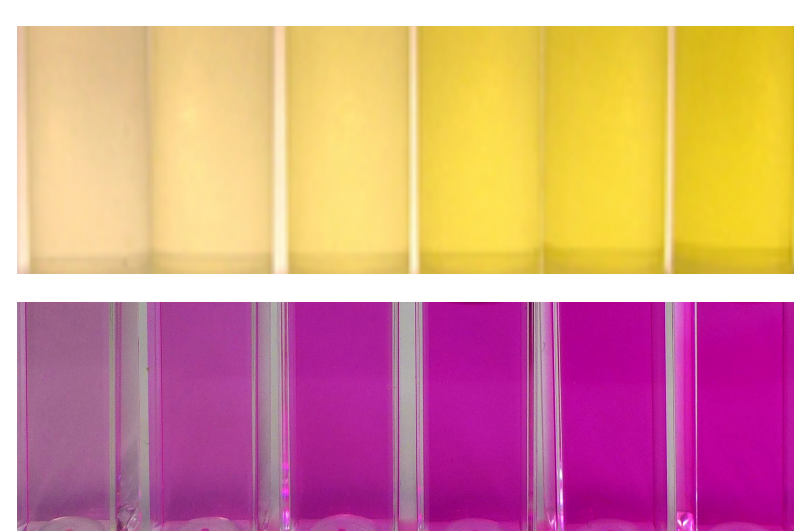
The nutrient platform utilises colorimetric chemistries for the detection of nutrients in marine and freshwater. The platform is adaptable to a number of colorimetric chemistries for the detection of Phosphate (PO_4^{3-}), Nitrite (NO_2^-) and Nitrate (NO_3^-).

Microfluidics
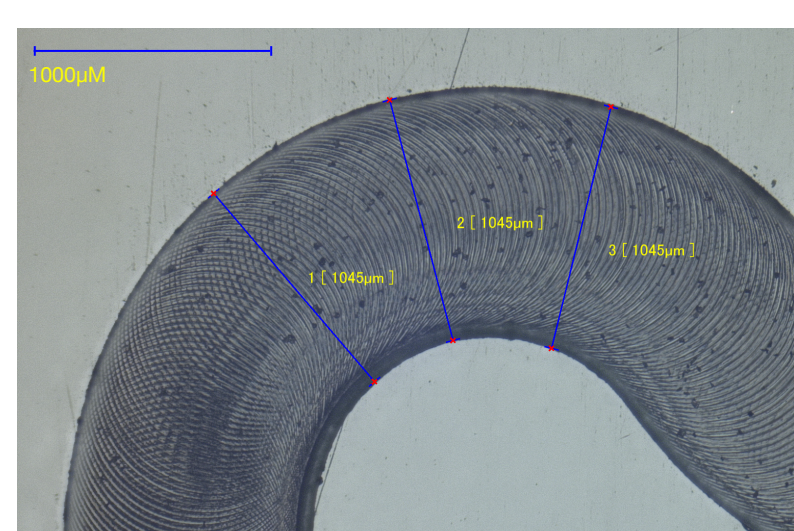
A two layer opaque PMMA microfluidic chip is integrated into the nutrient platform. The chip is comprised of two inlets and one outlet, a novel mixing pathway utilising shear forces to mix sample and reagent and a 2cm Optical detection pathway.

Optical Detection
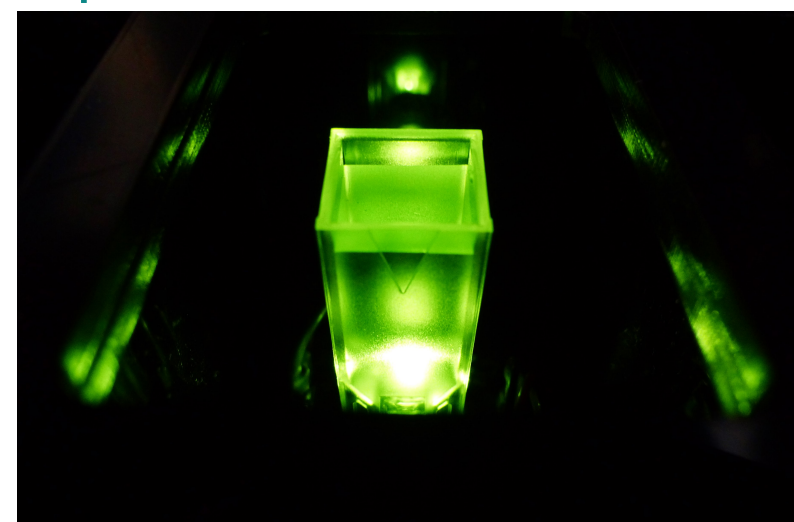
Optical detection is carried out through the use of a pulse width modulated LED and a photodiode detector positioned between the 2cm optical detection pathway. Phosphate (PO_4^{3-}) is detected using a 375nm LED, Nitrite (NO_2^-) and Nitrate (NO_3^-) are detected using a 545nm LED.

Electronics
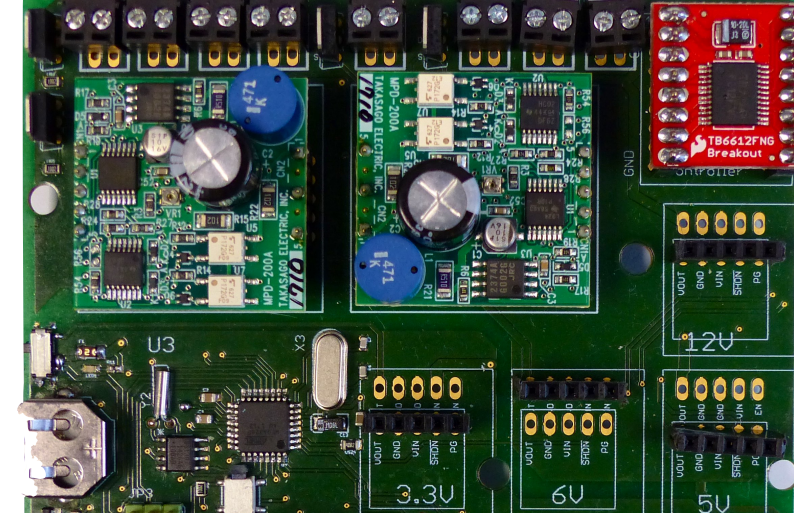
Integrated electronic's control platform automation; sample intake, data transmittance, internal calibrations and priming. Automation comprises of activation of inlet pumps, piezo electric pumps, 3/2 valves, 2/2 valves in order to sample calibrate and detect nutrients within the environment.
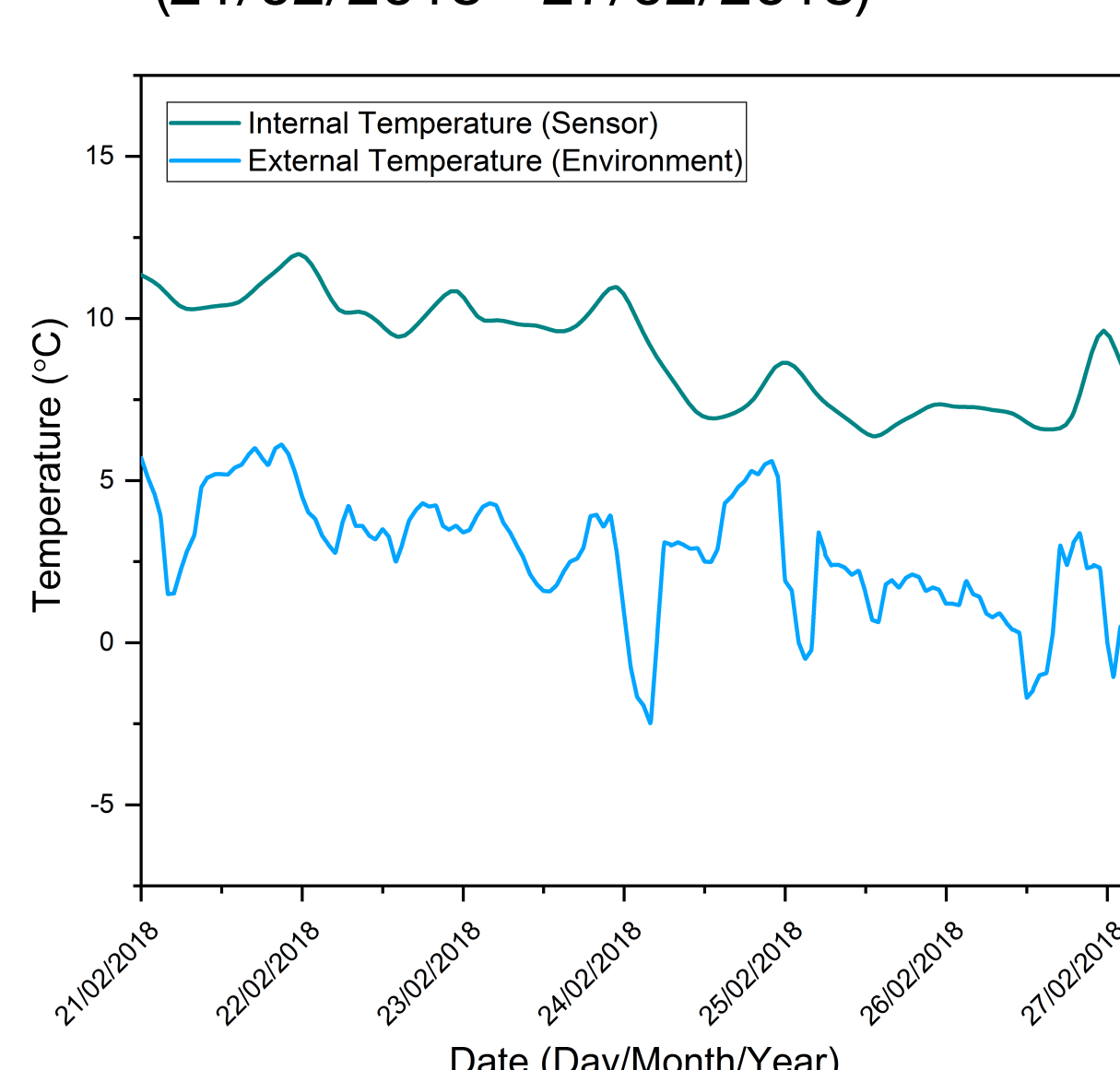
Deployment location
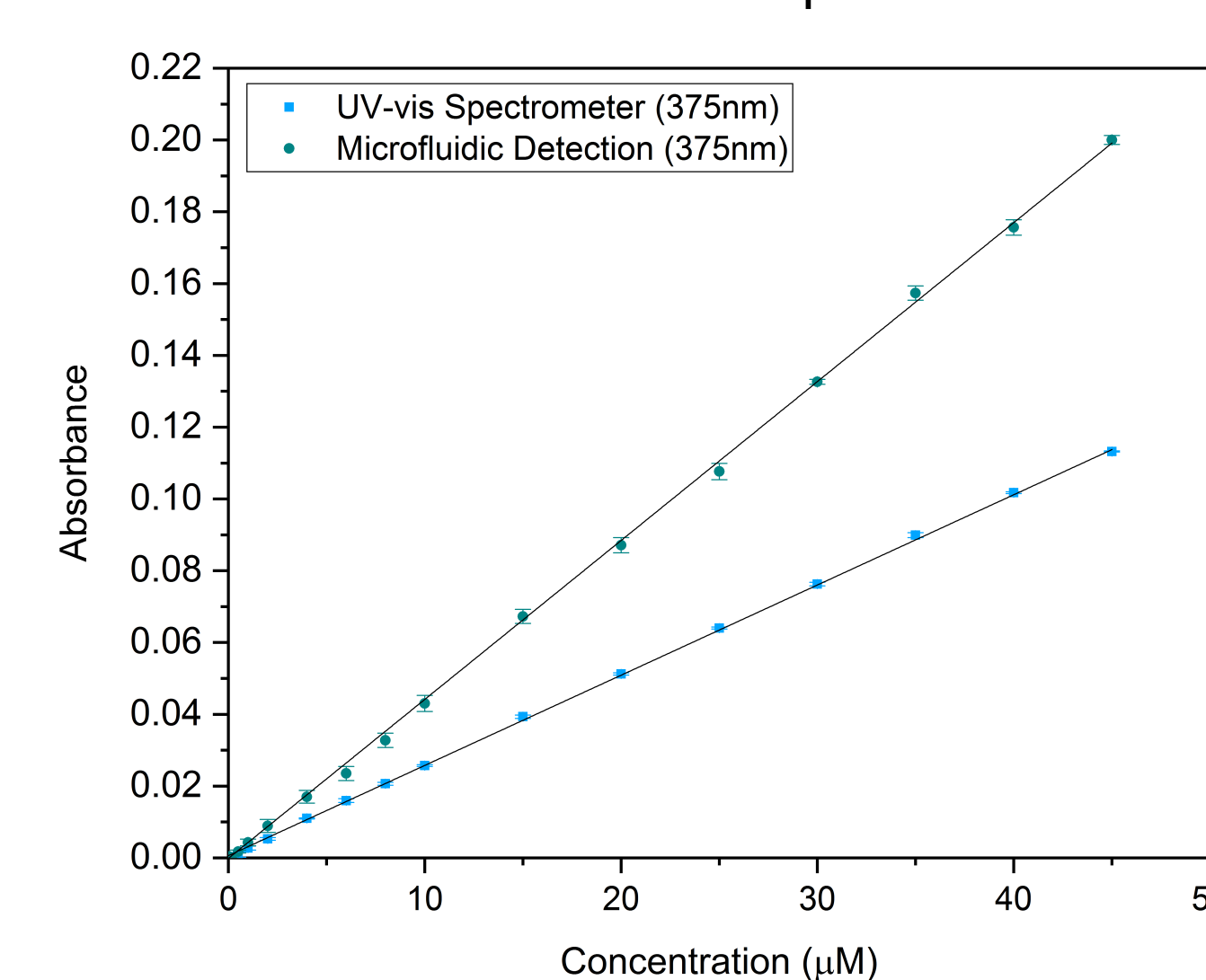River Liffey, Palmerstown, Dublin, Ireland

Sensor Deployment Location
53.356246, -6.3603255999999986
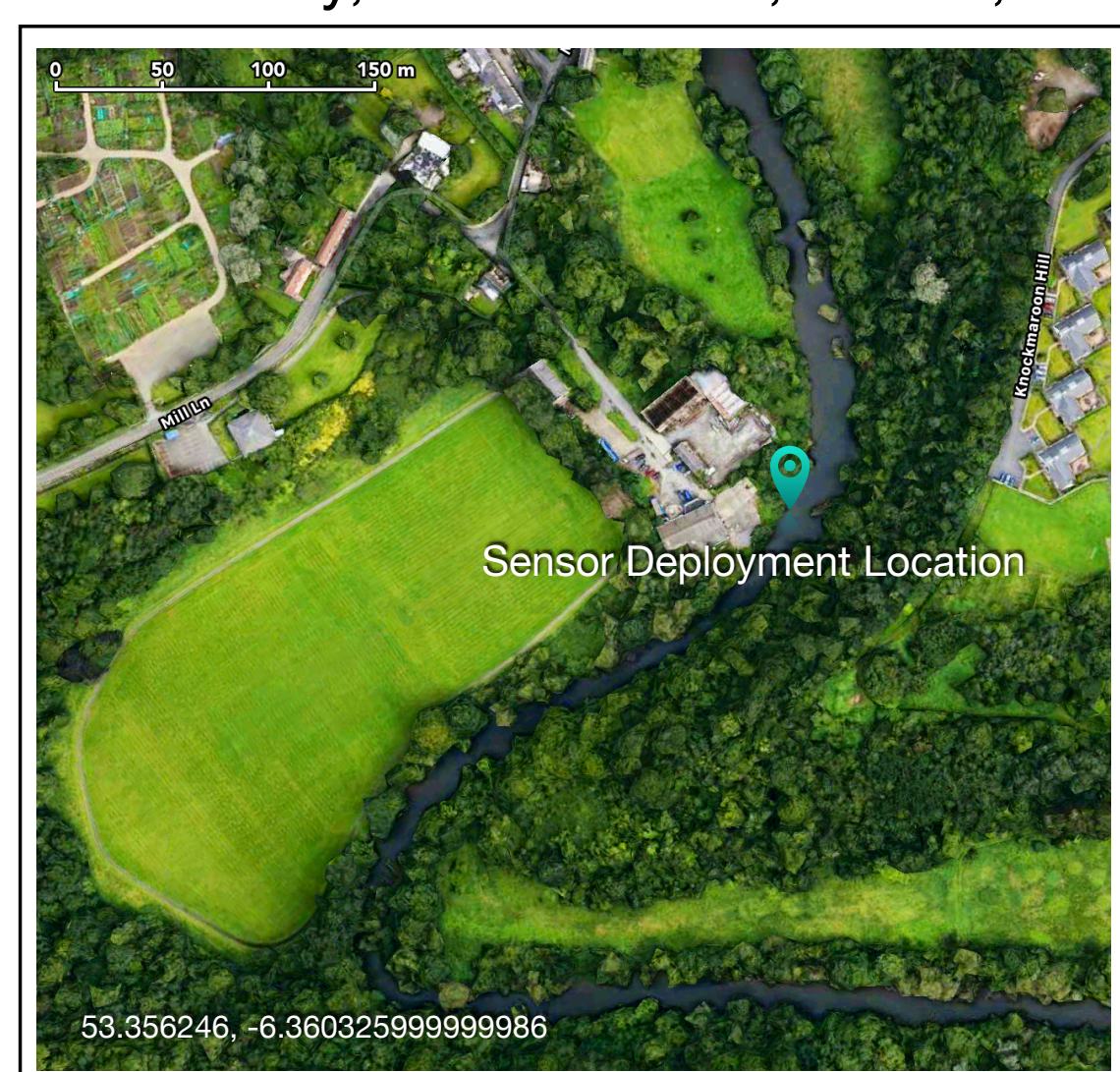
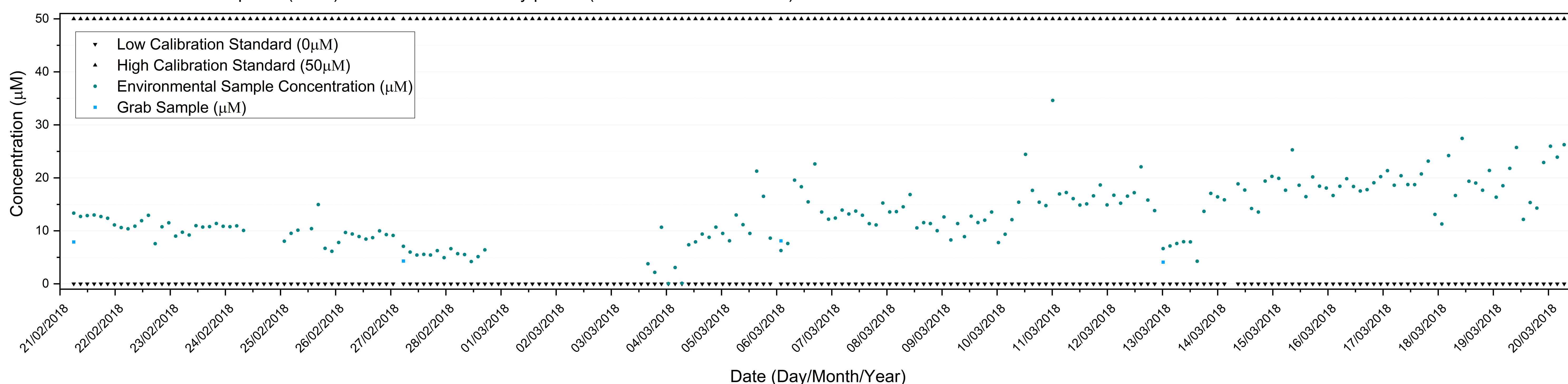River Liffey Water Levels (21/02/2018- 21/03/2018)
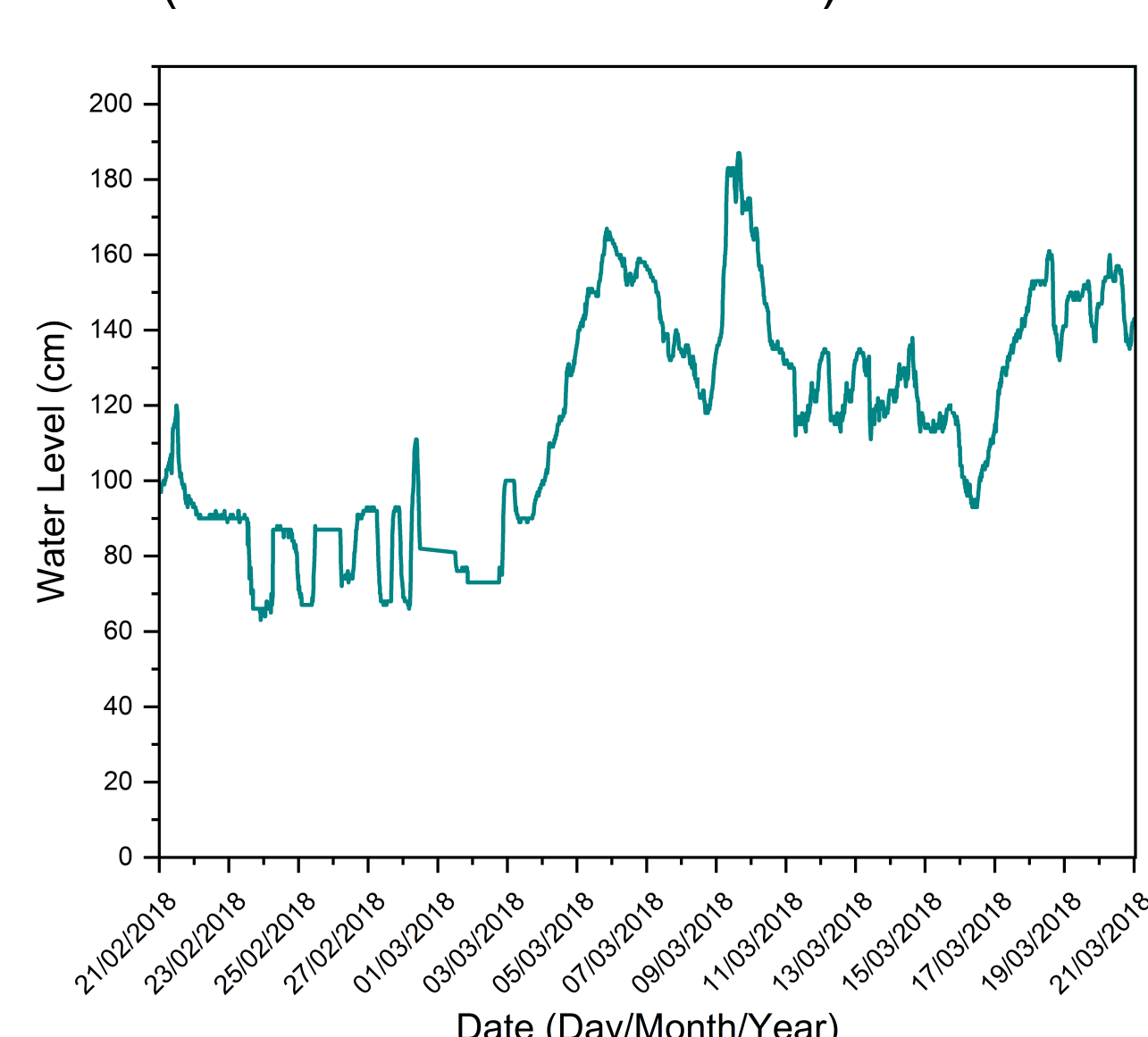
Internal and External Temperature (21/02/2018 - 27/02/2018)

Phosphate (PO_4^{3-}) Detection Nutrient Platform vs Spectrometer

Nutrient Platform Phosphate (PO_4^{3-}) detection over a 27 day period (21/02/2018 - 20/03/2018)

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