Next Generation Chemical Sensors: Detecting Nitrate and Ammonia in Water

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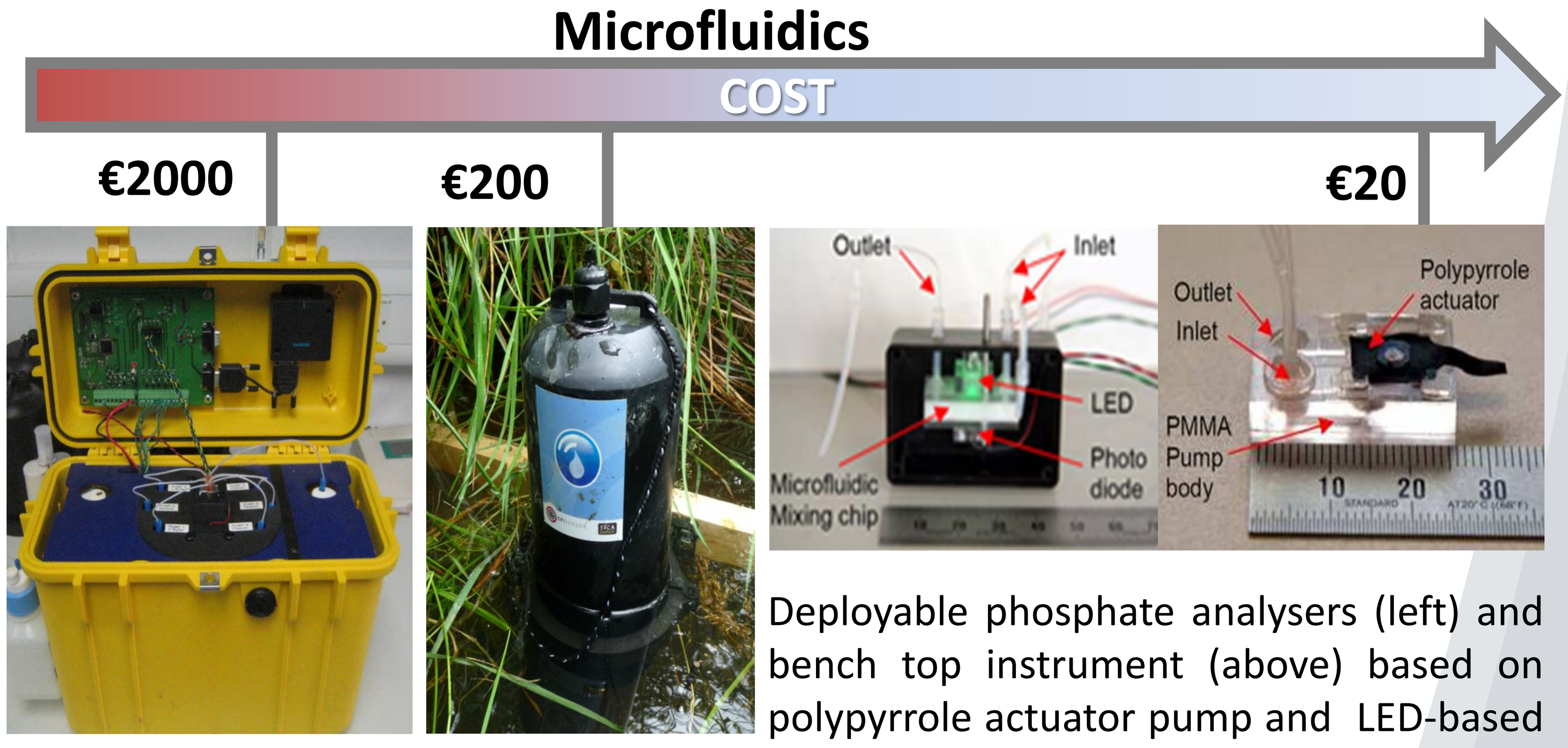
OVERVIEW

Monitoring and protecting the quality of environmental waters is of major concern today. Our ability to effectively monitor the aquatic environment is essential due to the increasing pressure on the environment from pollution, global climate change and the fact that water is an increasingly scarce natural resource.

Microfluidic technology has potential as a solution to the increasing demand for environmental monitoring; leading to the development of compact autonomous instruments for in situ continuous monitoring of remote locations over long deployable lifetimes.

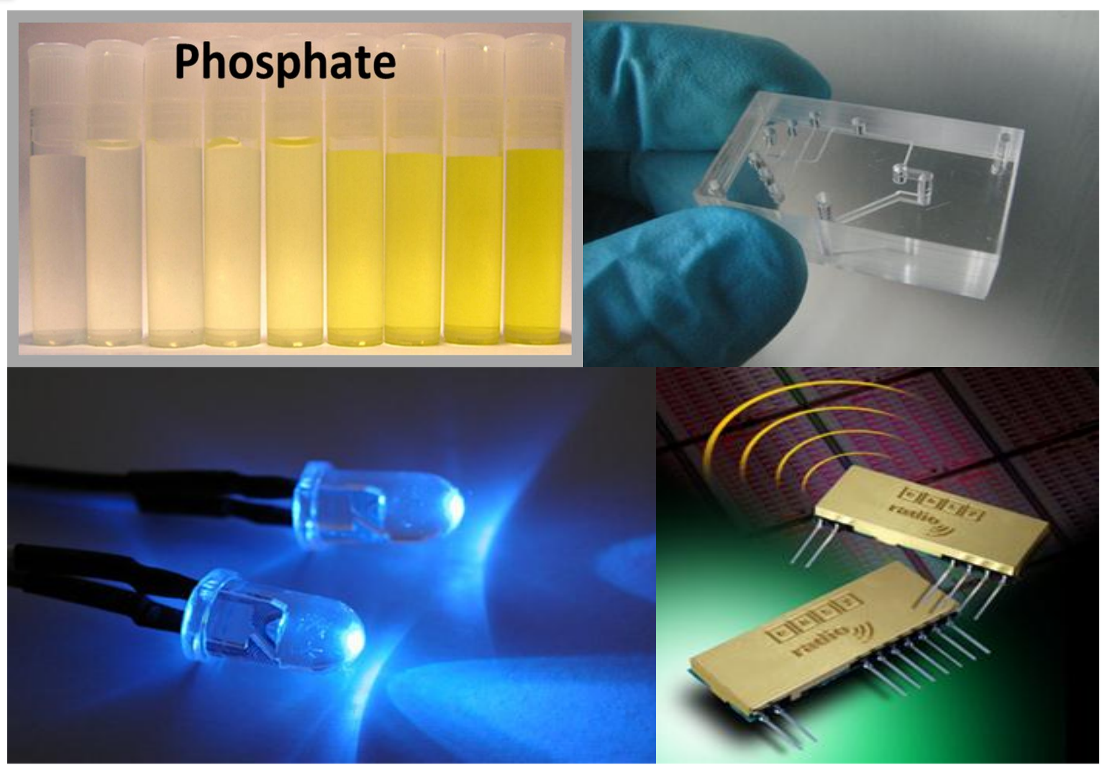
The objective of this research is to produce autonomous chemical sensing platforms with a price performance index that creates a significant impact on the existing market focusing on a detection platform for nutrients. The goal is to integrate polymer actuators valves into the microfluidic chip, to drive down the overall cost.



Generation 1 (Left €2000) and Generation 2 (Right €200) Phosphate Analyser.

Deployable phosphate analysers (left) and bench top instrument (above) based on polypyrrole actuator pump and LED-based optical detection.

COLORIMETRIC CHEMISTRY AND MICROFLUIDIC TECHNOLOGY

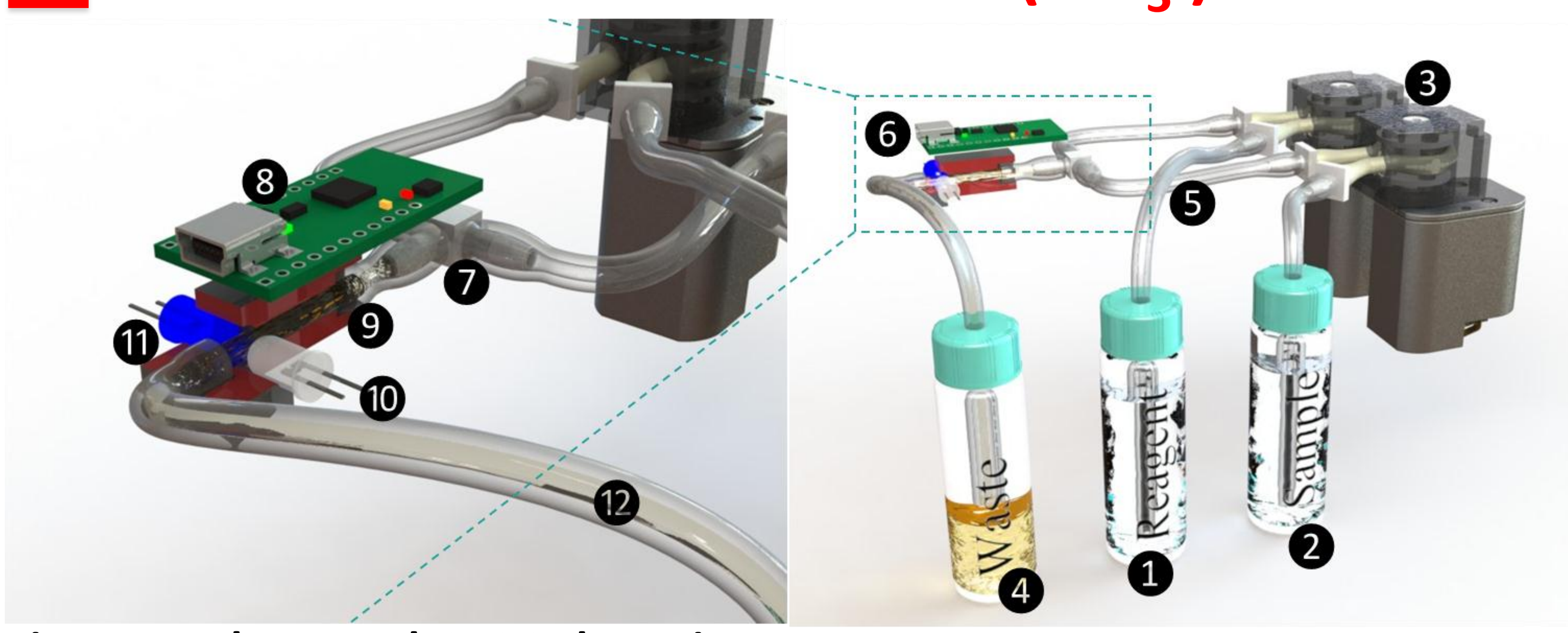


Colorimetric chemical assays, microfluidic chip, low cost LED/photodiode-based optical detection systems, and wireless communications.

- In order to drive down the cost of ownership of these devices, it is important to keep the fluidic handling requirement as simple as possible, as complex, multistage methods are difficult and expensive to implement as well as being less reliable in long-term deployments (high maintenance costs).
- Aim is to **simplify** standard colorimetric chemistries for easy integration into **microfluidic** platform with the objective of slashing component cost.

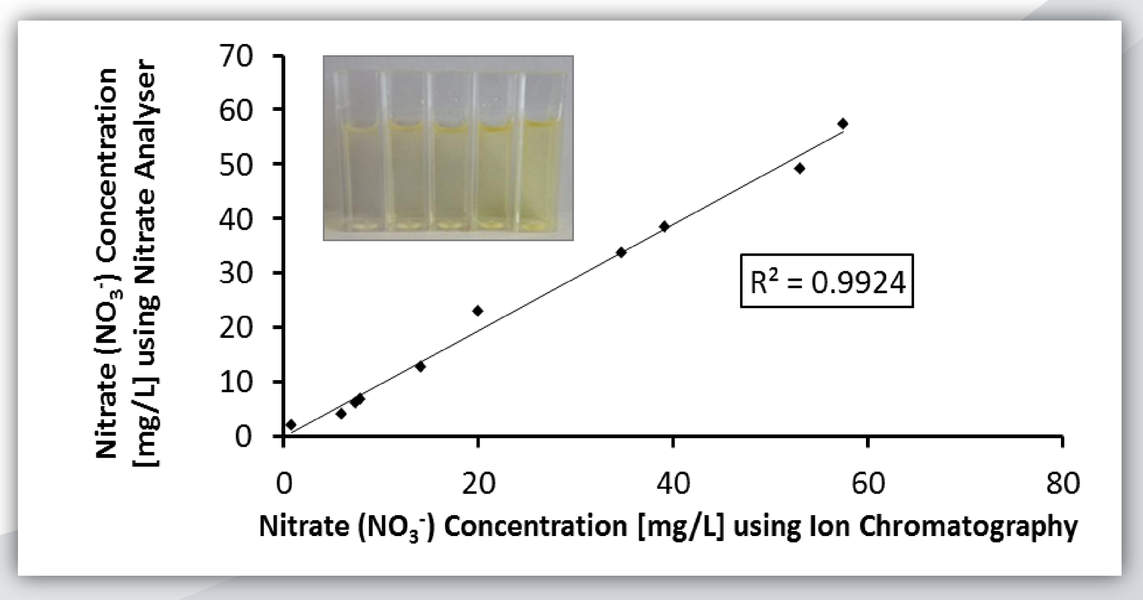
✓ Minimise reagent consumption and waste generation
✓ Minimise power consumption, allowing long battery lifetimes
✓ Allow the development of compact devices which are easy to transport and deploy
✓ Enhance sensitivity, reproducibility, and speed for certain assays

NITRATE DETERMINATION (NO_3^-)



Nitrate analyser and PEDD detection syst. (1) Reagent storage (2) Sample storage (3) Peristaltic micro pumps containing Santropene® tubing (4) Waste storage (5) Tygon® tubing (6) PEDD flow cell (7) Mixing junction (8) Wixel microcontroller with breakout board containing wireless serial link and data logger (9) Glass flow cell (10) Detector LED at 630 nm (11) Emitter LED at 430 nm (12) Waste line (Tygon tubing).

✓ **Simplified chromotropic acid method** eliminating several steps previously associated with this method.
✓ In sulphuric acid chromotropic acid reacts with nitrate ions and produces a yellow colour (λ_{max} = 430 nm).
✓ **Integrate into platform.**

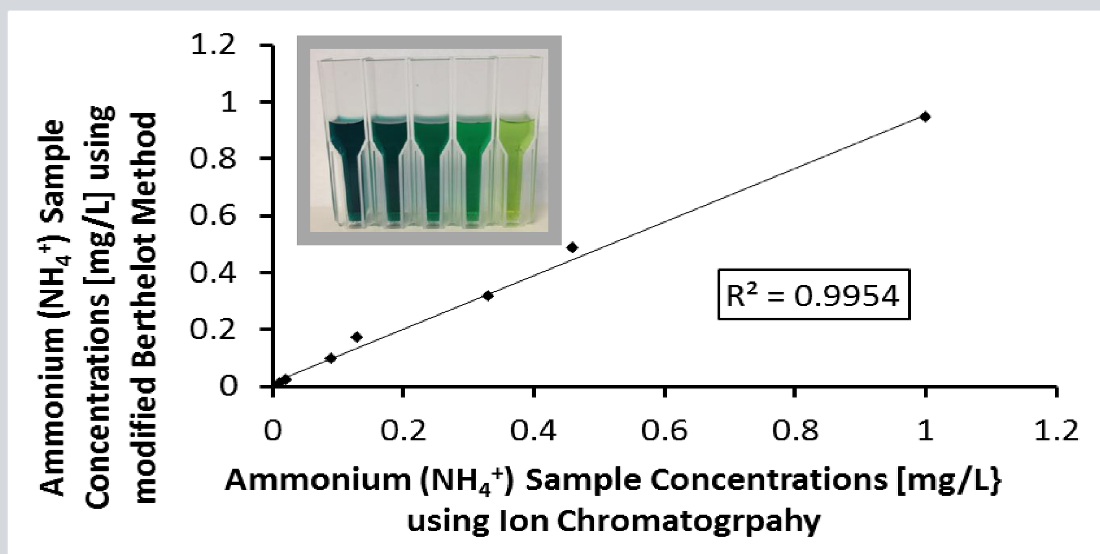


Linear response of 10 nitrate sample concentrations obtained by the nitrate analyser as a function of nitrate sample concentrations obtained using the standard method, ion chromatography.

DETERMINATION OF AMMONIA (NH_4^+)

The reagent cocktail includes a simplified variation on **the Berthelot method** which employs

✓ Salicylic acid instead of phenol which eliminates a toxic and relatively unstable reagent component.
✓ Intense colour generated is detected at a wavelength of 630nm.
✓ Previous method employs a three step reagent process (could prove complex in simple platform).
✓ Currently employing a mixed 2 step reagent process for a 1:1 sample to reagent ratio.
✓ Future work will include integration into autonomous sensing platform .



Linear response of 8 ammonia sample concentrations obtained by the modified Berthelot method as a function of ammonia sample concentrations obtained using the standard method, ion chromatography.

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