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Autonomous Nutrient Detection for Water and Wastewater Applications

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Overview

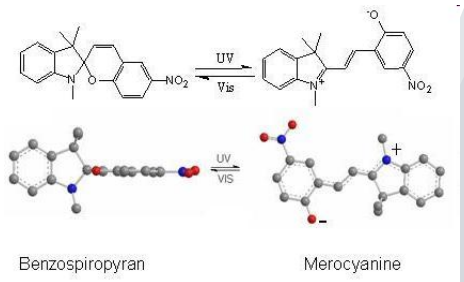
- Nutrient monitoring
- Phosphate Sensor
  - System Design & Operation
  - Deployments
- Nitrite and ammonia detection

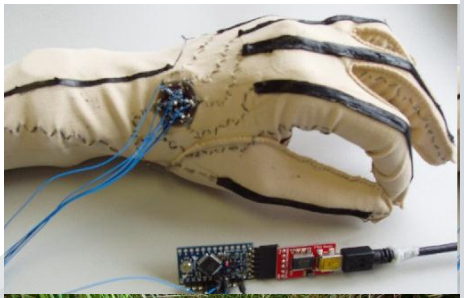
Adaptive Sensors Group

- Chemical sensing element of the CLARITY Centre

- Key research areas
  - Smart/Responsive Materials
  - Conducting Polymers
  - Optical & Electrochemical Sensors
  - Microfluidics / Lab on a chip
  - Autonomous Systems for Environmental Monitoring
  - Wearables

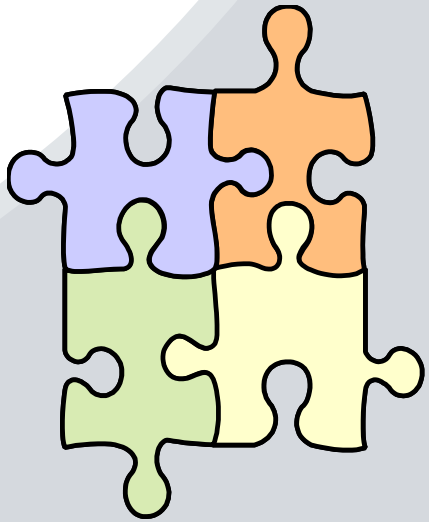
  - http://www.dcu.ie/chemistry/asg/





Autonomous nutrient monitoring

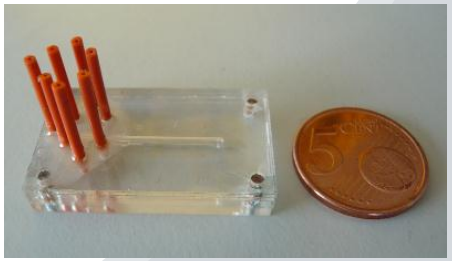
- **Targets:**
  - **Phosphate, Nitrate/nitrite, Ammonia**
- **Applications: Wastewater, surface waters**
- **Requirements:**
  - **Sensitive, selective and stable detection**
  - **Wireless communication of data**
  - **Low power consumption**
  - **Robust, portable**
  - **Low cost**
  - **Low maintenance**
  - **Deployable lifetime of 3+ months**



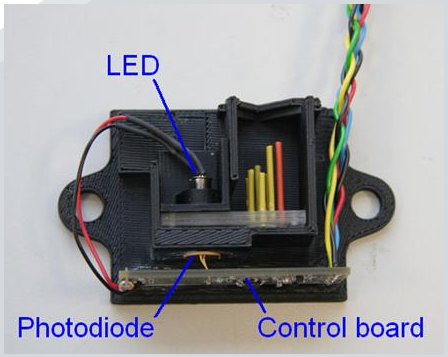
Approach

- Reagent based chemical detection

- Microfluidic technology

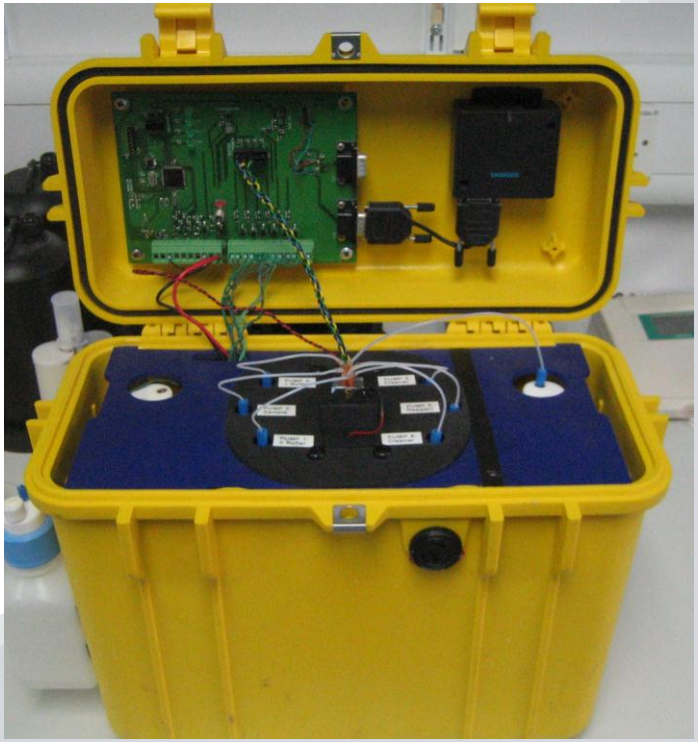


- Optical detection



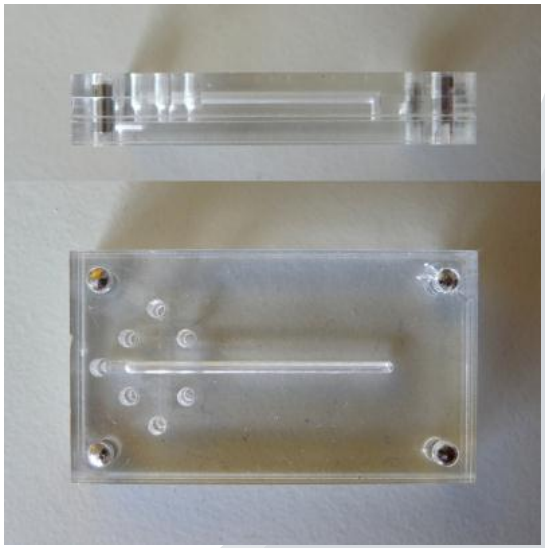
Phosphate analyser prototype

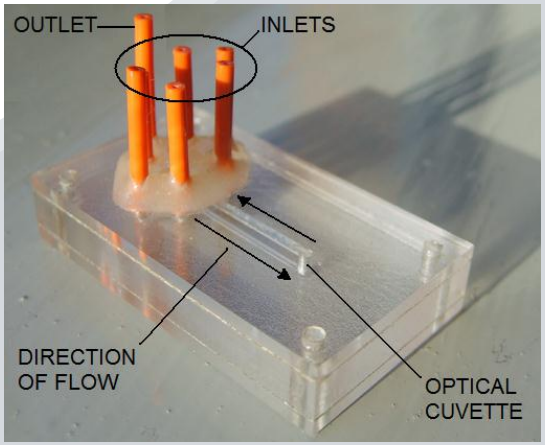
- Vanadomolydophosphoric acid method (yellow method)
- Simple, rugged microfluidic chip design
- GSM communication
- Solenoid pumps
- Robust casing



Microfluidic chip design

- Fabricated from PMMA layers
- Channels formed using a micro-milling machine
- Mixing channels 200x200µm
- Cylindrical optical cuvette (1mm diam. x 5mm length)





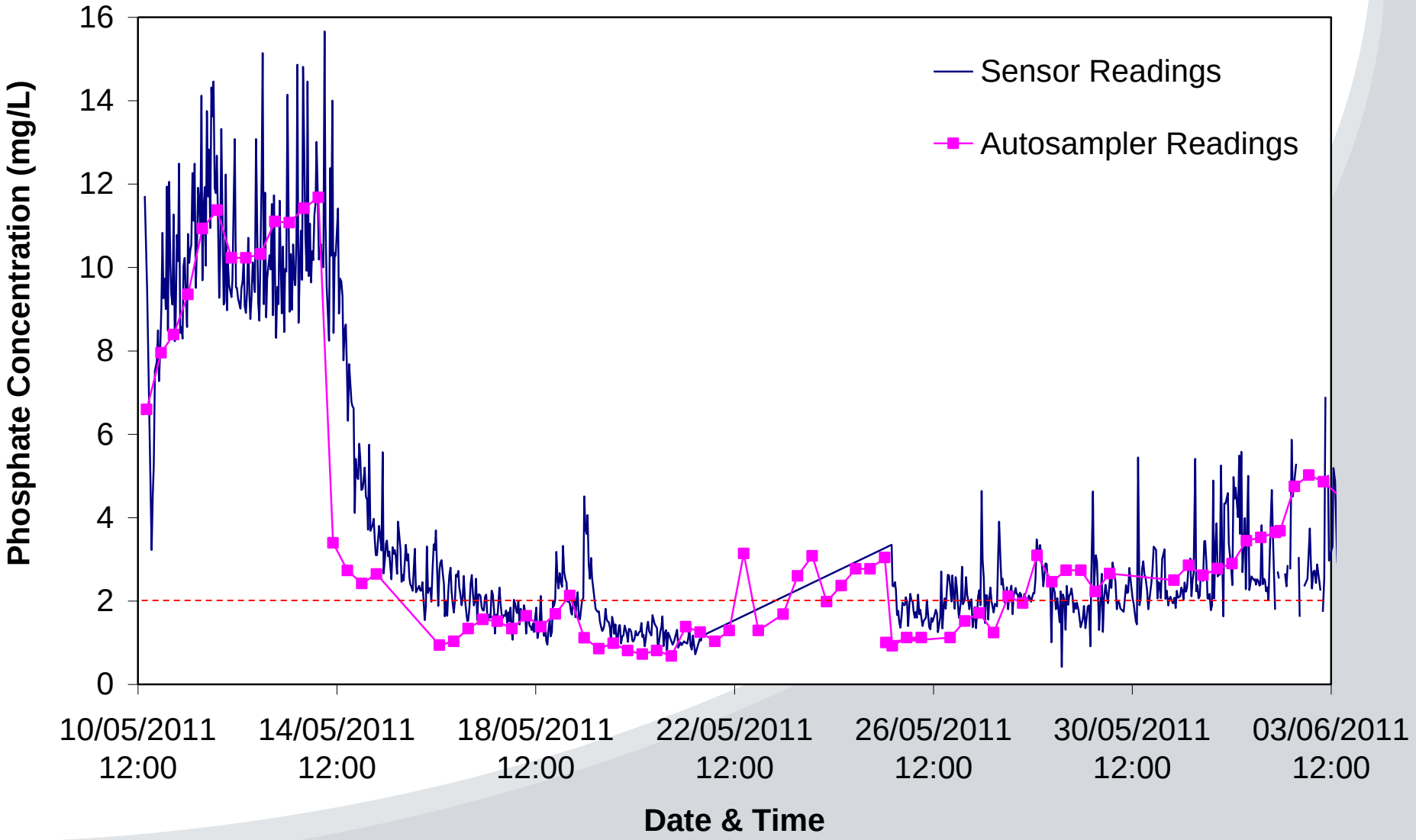
2nd generation system

- **Similar functionality with**
  - **Reduced footprint**
    - 2.3 vs. 15 L
    - 1.7 vs. 12 kg
  - **Extended battery life**
    - 12 vs. 2 months*
    - 3.6V LiSOCl vs. 12V lead/acid
  - **Zigbee radio**
    - real time reporting
    - remote control
    - “sensor to database”
  - **Reduced component cost**

WWTP trial

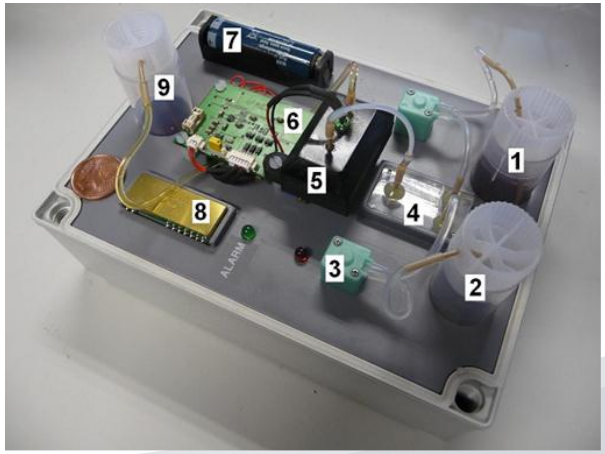
- WWTP in Co. Kildare, Ireland
- Sensor installed in effluent discharge tank
- 45 min sample interval
- Autosampler collecting 24 samples/week for validation

Trial data

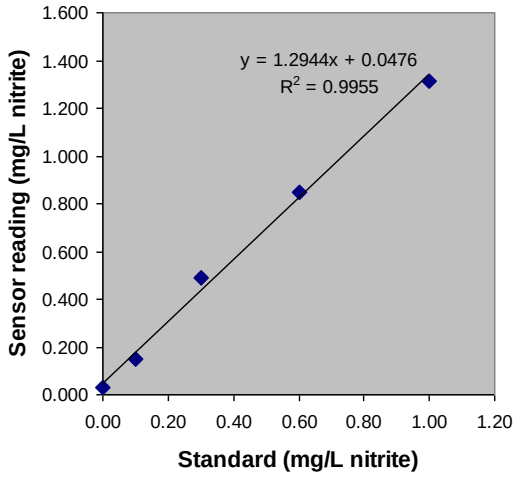

Phosphate Concentration (mg/L)
16
14
12
10
8
6
4
2
0
Sensor Readings
Autosampler Readings
10/05/2011 12:00
14/05/2011 12:00
18/05/2011 12:00
22/05/2011 12:00
26/05/2011 12:00
30/05/2011 12:00
03/06/2011 12:00
Date & Time

Nitrite system

- Analytical platform
- Colorimetric detection
- Modified Griess reaction
- Demo system
- Deployable unit



1. Reagent storage
2. Sample storage
3. Micro-pump
4. Mixing chip
5. Detector
6. Control board
7. Battery
8. Easy-Radio
9. Waste storage



Partners

- **Funding agencies**
  - Enterprise Ireland
  - Science Foundation Ireland
  - Marine Institute
  - Environmental Protection Agency

- **Industry**
  - Episensor Ltd.
  - TE Laboratories Ltd.