Marine Environmental Micro Sensors

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NOC

• Collaborative Centre (NERC - University of Southampton)
  • ~320 staff
  • ~750 undergraduate and postgraduate students.

• Collaborative Centre (NERC - University of Liverpool)
  • ~400 staff
  • ~40 Postgraduate students

NOC Sensors Development Group

Biogeochemistry: Global impact, hard to measure

An example challenge: In situ Ecogenomic Sensing Technology

Environmental Sample Processor (1999-Present)

454 sequencing (product launch 2006)
What will the impact be on science and society?

http://www.argo.ucsd.edu/index.html

FixO$^3$ An example of coordination to maximise impact and efficiency
Technologies

Optical hydrocarbon sensors

Electrodes on glass for physical and chemical sensing

Cytometry and single cell analysis

Capabilities

High quality microfabrication in plastic

Pressure tolerant electronics and systems

Capabilities

Rugged field proven technology with very high performance and miniature format

Fast-tracking development

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<th>TRL</th>
<th>Description</th>
<th>Technology</th>
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<td>1</td>
<td>Basic principles observed and reported</td>
<td>Lab on chip nucleic acid extractions, Cytometry</td>
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<td>2</td>
<td>Technology concept and/or application formulated</td>
<td>1. Lab on chip nucleic acid detection 2. Bio fouling methods</td>
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<td>3</td>
<td>Analytical and experimental critical function and/or characteristic proof-of-concept</td>
<td>Lab on chip carbohydrate sensors</td>
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<td>4</td>
<td>Technology basic validation in a laboratory environment</td>
<td>Lab on chip nutrient sensors</td>
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<td>5</td>
<td>Technology basic validation in a relevant environment</td>
<td>1. Lab on chip nutrient sensors</td>
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<td>6</td>
<td>Technology model or prototype demonstration in a relevant environment</td>
<td>Lab on chip nutrient sensors</td>
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<td>7</td>
<td>Technology prototype demonstration in an operational environment</td>
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<td>8</td>
<td>Actual Technology completed and qualified through test and demonstration</td>
<td>CT-DO</td>
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<td>9</td>
<td>Actual Technology qualified through successful mission operations</td>
<td>Lab on chip nutrient sensors</td>
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Fast-tracking development

- Funding for commercially viable technologies in Technology Readiness Level valley of death
- Large scale funding
  - Smaller but like that in cabled observatories or global float arrays
  - Must engage companies without which there will be no scale-up.
- Training of skilled multidisciplinary technologists: PhD, Chartered Engineers, Post docs, Technicians
- At higher TRLs knowledge transfer to users / industry
Examples

Lab on chip nutrient analysers

- High performance metrology with reagent based assays
- Lab-on-a-chip based analytical systems
- Typical precision ~ 7 nM
- Nitrate, Nitrite, Phosphate, Ammonia, Iron, Manganese...
- Any fluorescent or colorimetric assay
- Robust
  - 600 bar resistant

Fast measurement with precision

- Low concentrations = need the sensitivity of reagent based, or optical systems
- Fluidics =
  - Dispersion
  - Reaction Kinetics
  - Delay is inevitable
  - High frequency possible with dispersion compensation OR MULTIPLE DETECTION CHAMBERS
- Many chemicals and gases accessible

Carbon Observatory: pH

- Absorption based
- Colourimetric indicator (thymol blue)
- Microfluidics (flow cell volume: 128uL)
- LED source and photodiode detection
- Precision better than 0.0005 pH
- Temporal resolution: 1 point / 5 min
- Accuracy: 0.001 pH units
**Carbon Observatory: pH**

![8 days continuous ship board deployment example and comparison with single point sampling techniques](image)

**Biosensing: environment, health, water industry, defence**

![Image](image)

**Partners Sought**

- Co-development with grant funding
- Partners or suppliers
- Commercialisation: both with and without grant funding support

**Specific Opportunities**

- Next generation microfluidic analysers: nutrients, and carbonate (CO₂ system) parameters, small, fast, cheap
- Current or near future calls
  - Biosensors for biohazard and chemical contaminants
  - Multifunctional in situ sensors
  - Biofouling mitigation
- Commercialisation: Lab on a chip nutrient sensors

**Selected References**