

Marine Environmental Micro Sensors

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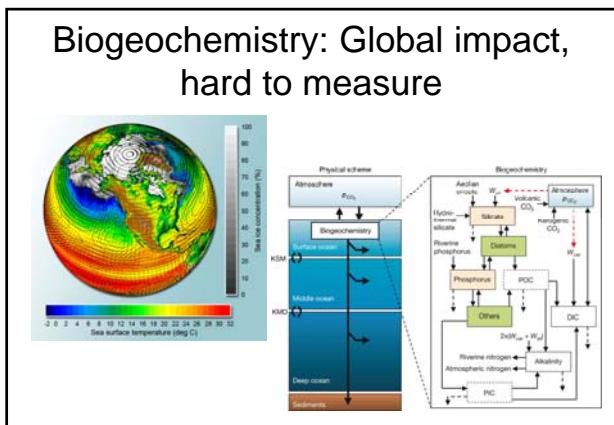
NOC

- Collaborative Centre (NERC - University of Southampton)
- ~520 staff
- ~700 undergraduate and postgraduate students.

- Collaborative Centre (NERC - University of Liverpool)
- ~140 staff
- ~40 Postgraduate students



NOC Sensors Development Group



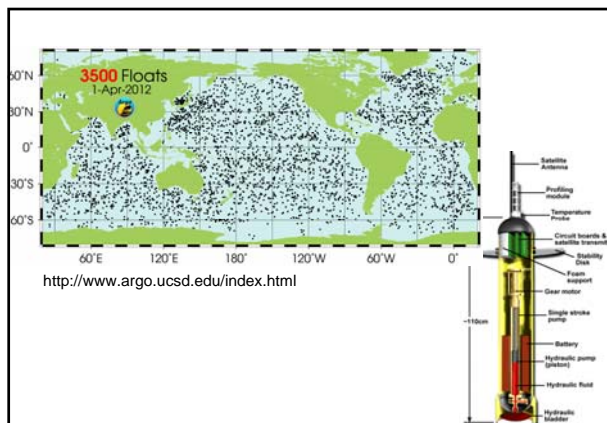
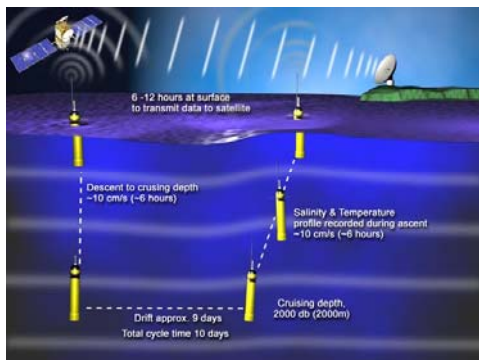
An example challenge: In situ Ecogenomic Sensing Technology

Environmental Sample Processor (1999-Present)

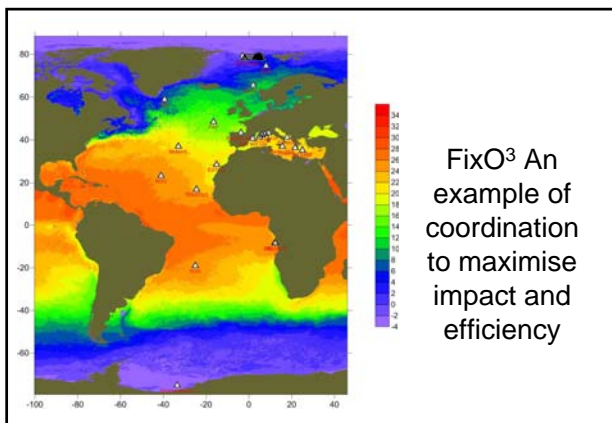
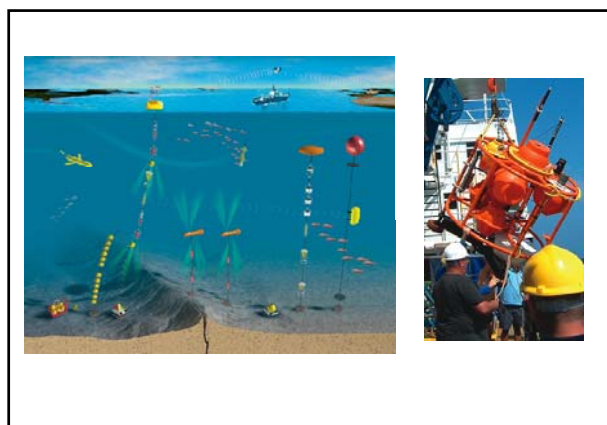
454 sequencing (product launch 2006)

a) library fragmentation and ligation b) single fragment immobilised on bead, bead enters well c) PCR product immobilised to bead, bead enters well d) addition of enzymes e) SEM of wells f) overview of system: Nature Biotechnology 26, 1117–1124 (2008). doi:10.1038/nbt1485

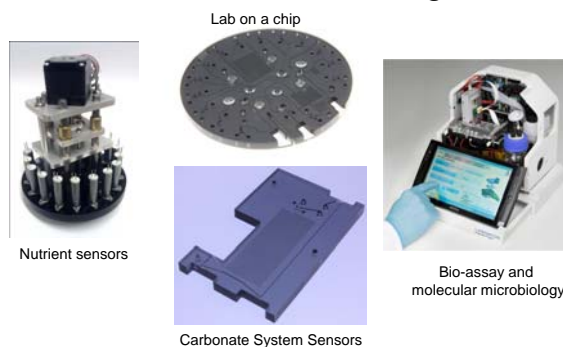
What will the impact be on science and society?



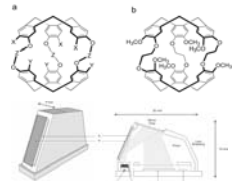
sensors on gliders (initially in shelf seas)



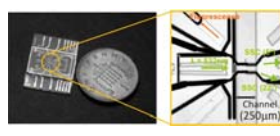
Future Blue Technologies



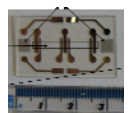
Technologies



Optical hydrocarbon sensors

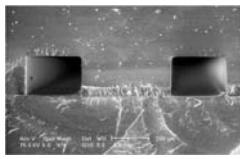


Cytometry and single cell analysis




Electrodes on glass for physical and chemical sensing

Capabilities




High quality microfabrication in plastic

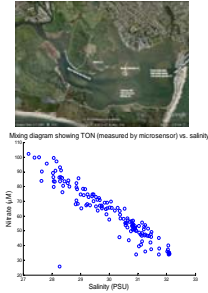


Pressure tolerant electronics and systems

Capabilities



Rugged field proven technology with very high performance and miniature format



Map diagram showing TON (measured by microsensors) vs. salinity

Fast-tracking development

TRL	Description	Block
1	Basic principles observed and reported	
2	Technology concept and/or application formulated	
3	Analytical and experimental critical function and/or characteristic proof-of-concept	
4	Technology basic validation in a laboratory environment	Paper has been produced, standard research funding dries up
5	Technology basic validation in a relevant environment	You've done it once, now commercialise it!
6	Technology model or prototype demonstration in a relevant environment	Valley of death
7	Technology prototype demonstration in an operational environment	
8	Actual Technology completed and qualified through test and demonstration	Take up, and investment for commercialisation
9	Actual Technology qualified through successful mission operations	Take up, and investment for commercialisation

Fast-tracking development

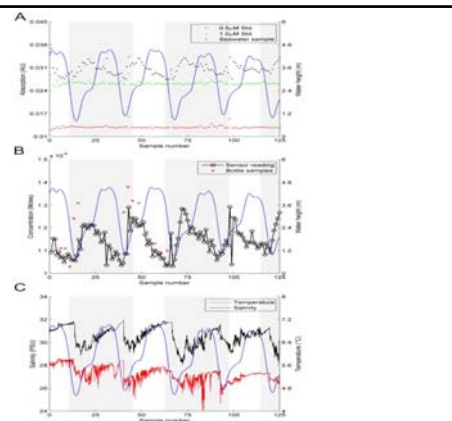
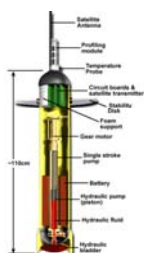
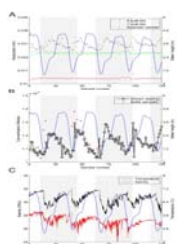
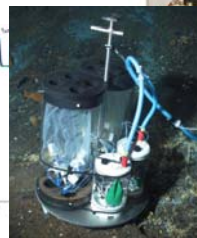
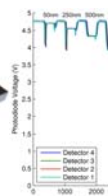
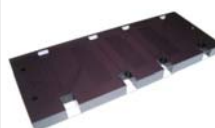
TRL	Description	Technology
1	Basic principles observed and reported	
2	Technology concept and/or application formulated	
3	Analytical and experimental critical function and/or characteristic proof-of-concept	
4	Technology basic validation in a laboratory environment	Lab on chip nucleic acid extractions, Cytometry
5	Technology basic validation in a relevant environment	1. Lab on chip nucleic acid detection 2. Bio fouling methods
6	Technology model or prototype demonstration in a relevant environment	Lab on chip carbonate sensors
7	Technology prototype demonstration in an operational environment	Lab on chip nutrient sensors
8	Actual Technology completed and qualified through test and demonstration	CT-DO
9	Actual Technology qualified through successful mission operations	1. Bio Assays for pathogens and species of scientific interest 2. Evaluation of biofilms

- ## 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

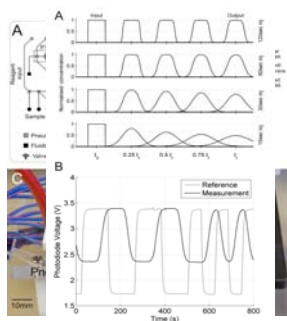
Lab on chip nutrient analysers

- 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

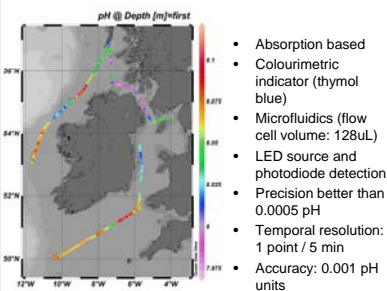


Fast measurement with precision

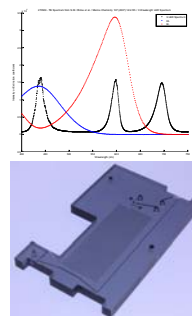
- Low concentrations = need the sensitivity of reagent based, or optical systems
- Fluidics =
 - Dispersion
 - Reaction Kinetics
 - Delay is inevitable
 - High frequency possible with dispersion compensation OR **MULTIPLE DETECTION CHAMBERS**
- Many chemicals and gases accessible



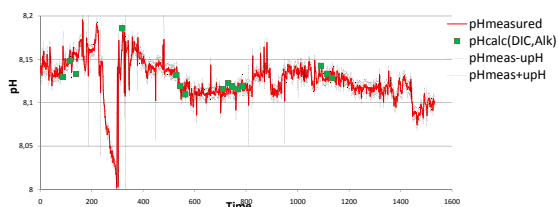
Carbon Observatory: pH



- 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

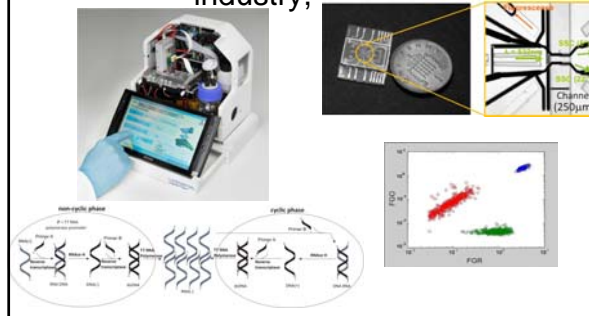


Carbon Observatory: pH



8 days continuous ship board deployment example and comparison with single point sampling techniques

Biosensing: environment, health, water industry, defence



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

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