

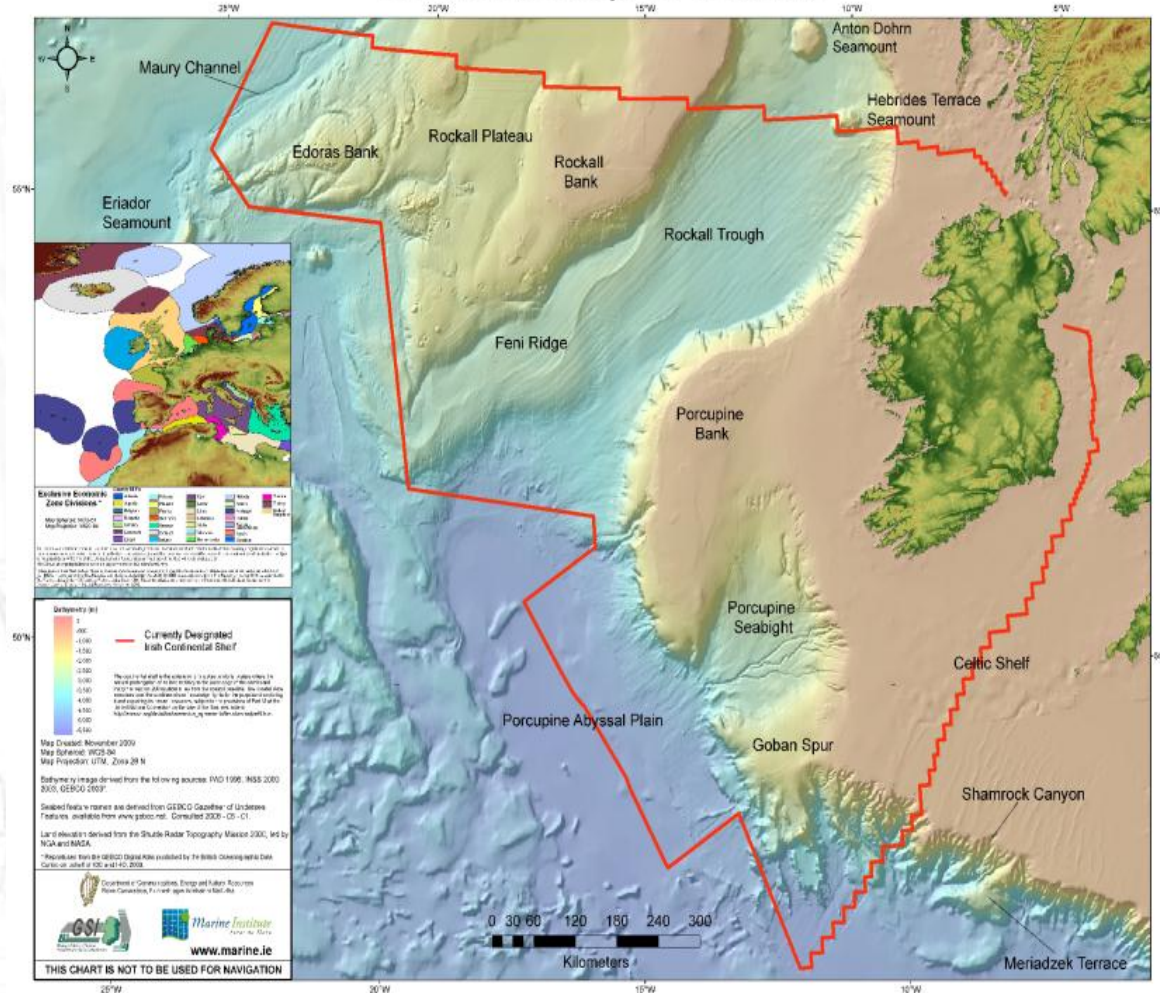
# **Sensing technologies for monitoring the marine environment**

by

Lorna Fitzsimons

King Tong Lau, JungHo Kim, Timothy O'Sullivan, Edwina Stack, Edel O'Connor, Aine Moyna, Fiona Regan, Dermot Diamond, Alan Smeaton, Noel O'Connor, Brett Paull and Richard O'Kennedy

## The Real Map of Ireland



### Introduction

Marine research in Ireland

MESTECH

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Conclusions and future work

# The Beaufort Marine Research Awards

- Launched in early 2007
- Funding scale ~ €20 million
- Created 140 new positions for researchers and students across Ireland
- Supports five research areas
  - Ecosystems Approach to Fisheries Management
  - Marine Biodiscovery
  - **Marine Sensors and Communications**
  - Fish Population Genetics
  - Marine Economic & Social Research

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# Marine and Environmental Sensing Technology Hub

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- The SmartOcean strategy launched by the Marine Institute in 2010
  - Vision: strong industry cluster in marine sensors and ICT
- MESTECH set up at the request of Marine Institute, Ireland
  - Launched in March 2011
  - Housed in NCSR, DCU
- **Focused on the development of innovative approaches to marine related sensing and communication technologies**

# MESTECH Collaboration



## Chelsea Technology Group



# Research thematic areas

Biofouling mitigation

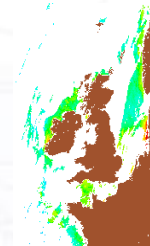


Chemical separations



Marine sensing and communications

Visual sensing and image analysis



Micro-fluidic platforms



Biorecognition

**Goal: Development of Innovative technologies for real time long term marine monitoring**

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## Biofouling mitigation – Tim Sullivan and Prof. Fiona Regan

- Biofouling can generally be defined as the unwanted accumulation of micro-organisms on artificial surfaces e.g. bacteria, diatoms, invertebrates
- Biofouling - data drift, data loss and in extreme cases sensor loss or total malfunction

**Biofilm thickness of 100  $\mu\text{m}$  – 1 mm within 7 -14 days during summer periods**



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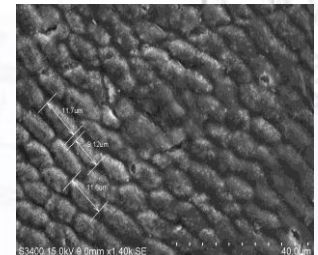
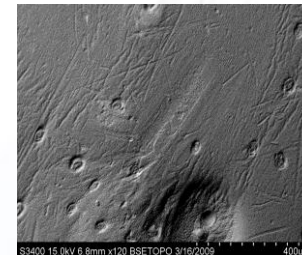
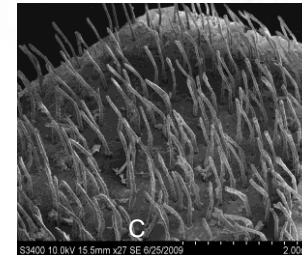
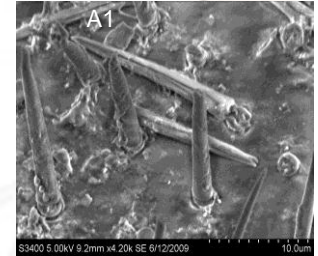
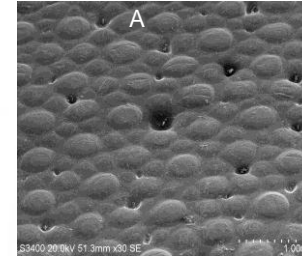
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## Nature inspired surface modification

- Based on understanding of apparent non-fouling organisms in the marine environment - e.g. shark skin
- Analysis of the structure, fractal patterning, shape and dimensions of surface features
- Production and testing of replicates or bio-mimetic analogues of the surface textures



SEM images of crustacean species showing macro features (A) *Cancer pagurus*, (B) *Pecora nuber*, (C) *Hommarus gammarus* and corresponding microfeatures (A1, B1 and C1).

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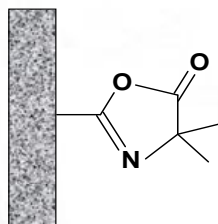
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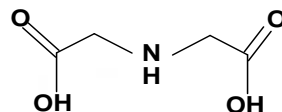
Conclusions and future work



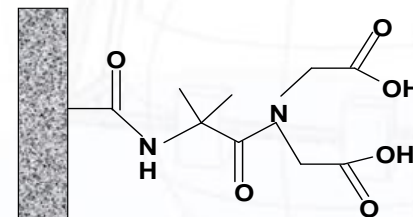
- Development of micro-separation science technologies
- Novel technique to separate and detect heavy and transition metals in complex environmental samples (e.g. seawater)
- Prepare the base monoliths – chelating ligand (claw-like) holds the metals



**azlactone**



**IDA**



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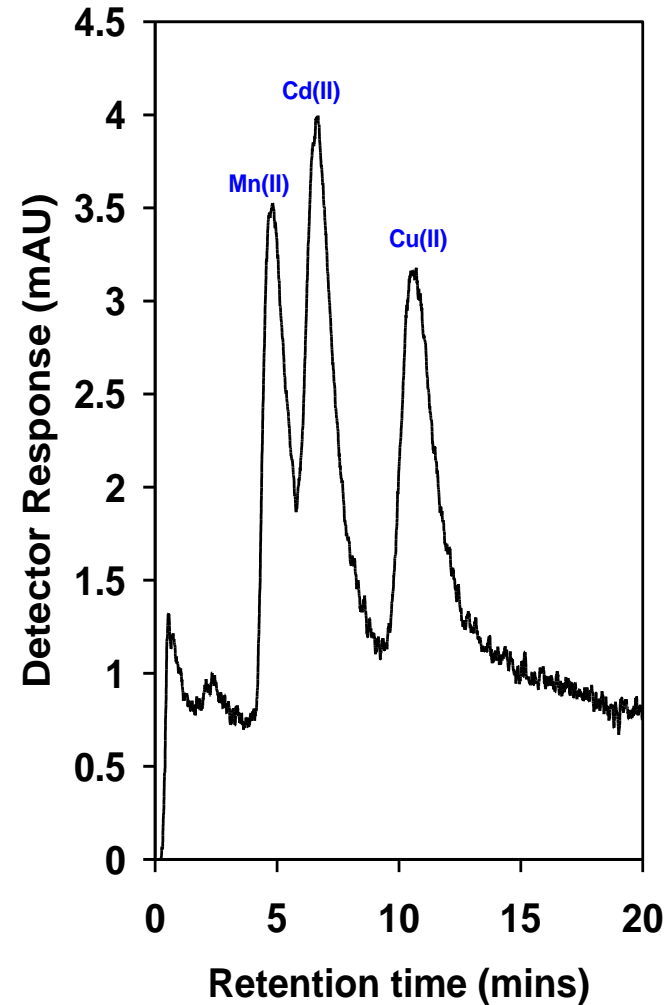
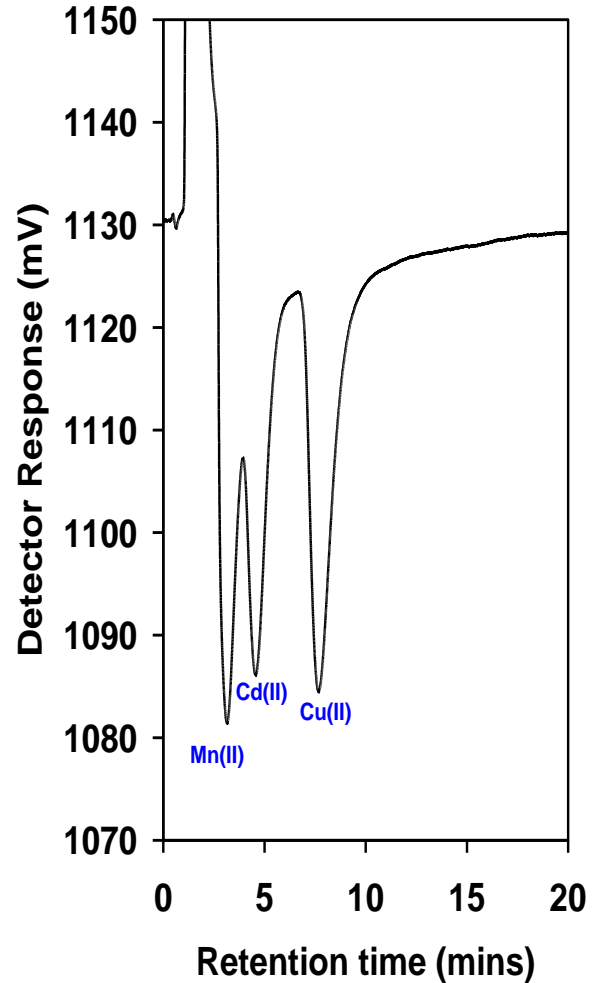
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## Separation of metals with simultaneous on-column C<sup>4</sup>D and UV-Vis detection



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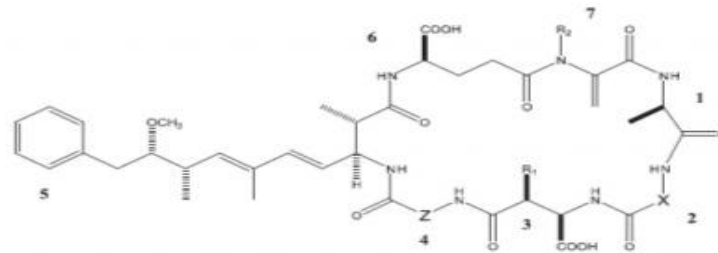
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## Marine biotoxin detection – Edwina Stack and Prof. Richard O’Kennedy

- Toxin – producing cyanobacteria (Blue-green algae) accumulate in the marine environment causing severe human and animal intoxication
- No means for rapid and reliable detection
- Urgent requirement for sensitive and reliable methods for toxins and their producers in a wide range of sample matrices

### Targets of Interest for Recombinant Antibody Production:

Cyanobacterial toxin, microcystin, Paralytic Shellfish poisoning (PSP) toxins



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# Production of toxin conjugates and immune response generation

Commercial synthesis of MC-LR-OVA and MC-LR-BSA protein conjugates via N-methyldehydroalanine residue

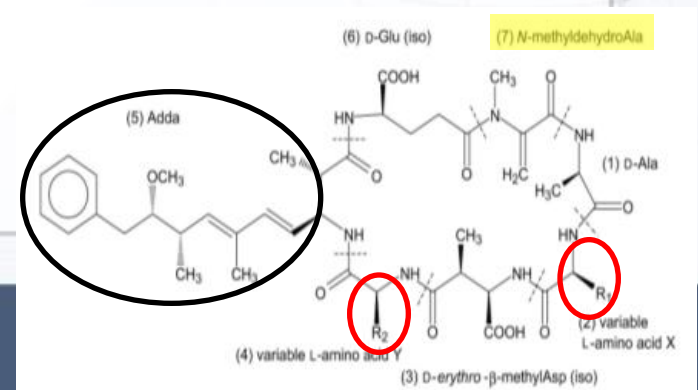
Immunisation of animal hosts and immune response generation

Outcomes:

- Polyclonal antibody to MC-LR
- Recombinant antibody to MC-LR

For:

1. Biacore SPR-based assay
2. High sensitivity platform-based assay



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## Video Image Analysis – Edel O'Connor, Prof. Alan Smeaton and Prof. Noel O'Connor

- Development of Visual data analysis and quality determination software
- Image stream in real time for monitoring the environment
- Accumulation of sufficient data can be used to predict future (weather) trends
- Applications
  - Water level monitoring
  - Flood warning

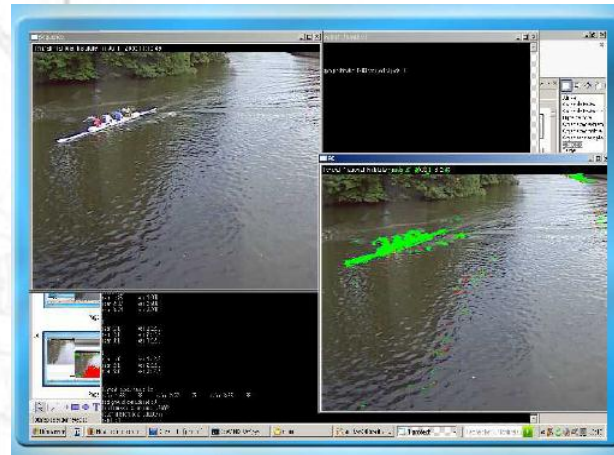
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# Adaptive sampling

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**Water level prediction for adaptive sampling of sophisticated chemo-sensor**



# Multi-channel Optical Device (MOD)

Prof. KT Lau, Prof. Dermot Diamond and Dr. JungHo Kim

- LED array as light source
- Measure colour and clarity of water
- High sampling frequency
- Real-time wireless data transmission
- For water quality management
  
- Algae bloom
- Algae speciation

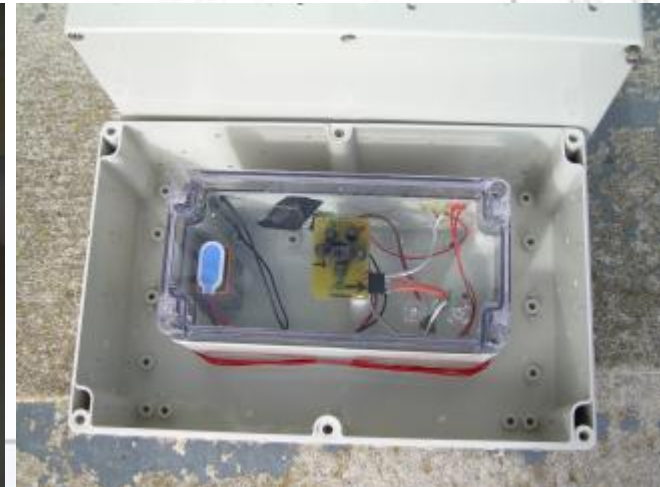
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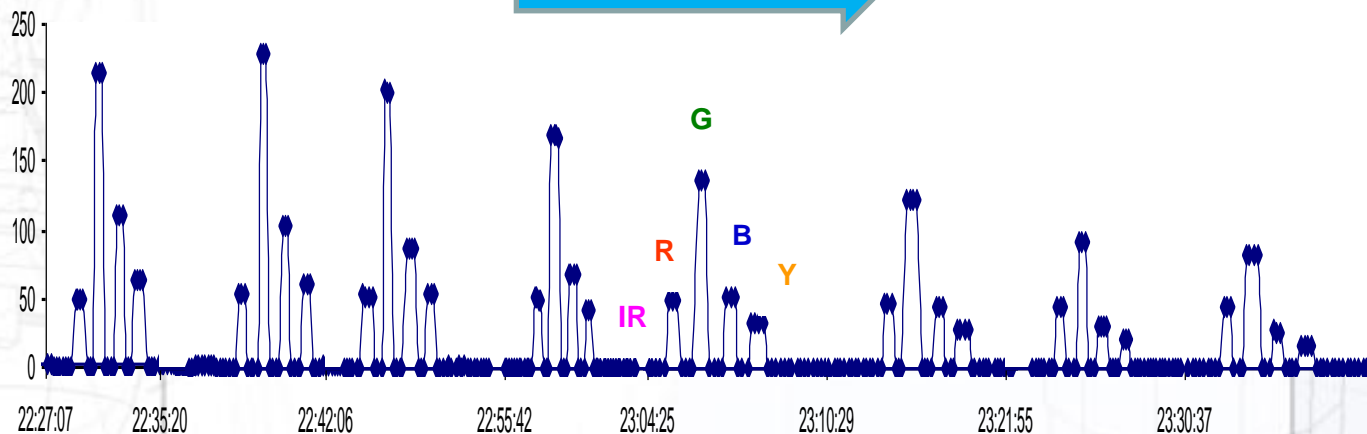
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# Multi-channel Optical Device (MOD)

**MOD output showing change of output pattern with increasing turbidity**

Increasing turbidity



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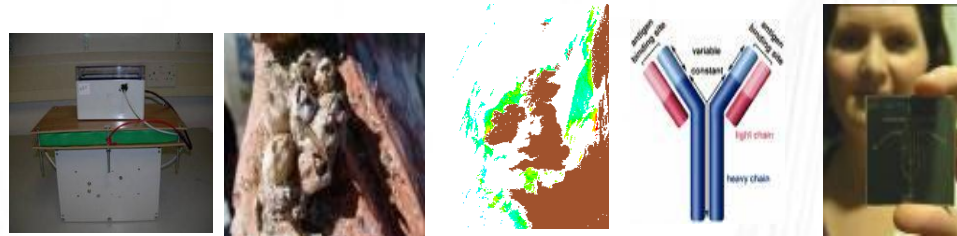
Conclusions and future work



## Conclusions and future work

**MESTECH - multi-disciplinary environmental sensing**

**Biofouling, chemical separations, visual sensing, biorecognition and optical sensing**



### Generic Electronics Platform

Power

Communications

Control

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Thank you  
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