ÆMORE - Acoustic Emission technology for environmental and engineering health Monitoring of Offshore Renewable Energy

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Hosting Institution: University of Exeter

Project description

Background: The future electricity generation will considerably rely on offshore renewable energy (ORE) sources, including offshore wind, wave and tidal energy generation. The projections for the UK state that over 10% of the electricity will be generated offshore by 2020.

The underpinning science of acoustic emission monitoring plays a pivotal role in quantifying the environmental impact that offshore renewable developments have on marine life and ecosystems. A review commissioned by the Crown Estate showed good progress in measuring underwater noise levels for ORE technologies.

Aim & Objective: This proposal aims to extend the remit of acoustic emission monitoring beyond the environmental sciences into the engineering assessment and monitoring of submerged structures. Acoustic emission monitoring is widely used for fault detection and health monitoring of land-based systems [1]. The research challenge is to develop measurement arrangements and algorithms to accurately identify acoustic signatures for individual technologies and, more specifically, to monitor wear and failure mechanisms of components submerged in the complex and dynamic marine environment.

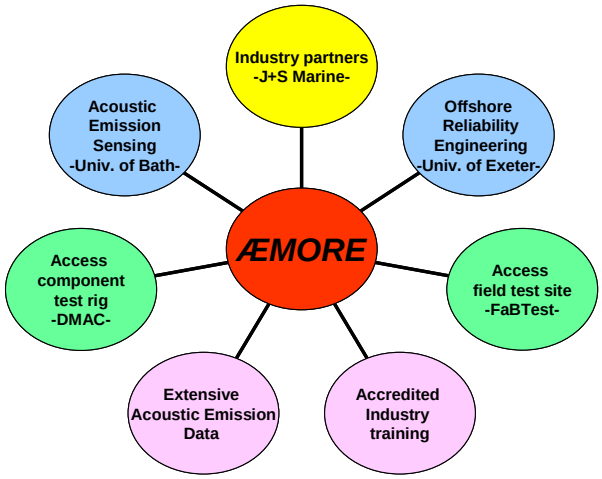
Project outline: This interdisciplinary proposal seeks to combine the physical understanding and best practice of acoustic underwater remote sensing (Univ. of Bath) with the expertise in reliability engineering for floating ORE systems (Univ. of Exeter). This project is a world-first application of acoustic emission techniques for combined environmental and engineering condition monitoring for ORE installations (see Figure). The project will benefit from the provision of:

- Extensive environmental noise data collected over two year period at Falmouth Bay test site (FaBTest), covering baseline data, installation and operation phases for wave energy converter.
- Access to regular sensor deployment opportunities and established environmental site measurements through granted Regional Growth Fund (worth £770k).
- Access to Dynamic Marine Component test rig (DMaC) for lab-based experimental investigation of sound signatures.
- Access to University of Bath test tank for specification of measurement strategies under controlled noise generation scenarios

Pilot study results: Measurements from Passive Acoustic Monitoring (PAM) instruments to assess background noise levels in Falmouth Bay have identified sound exposure due to shipping [2]. More

recent data from an Exeter/Bath/industry collaboration identified specific sound features during wave energy converter operation.

Outcomes: The outcome of this proposal will more accurately characterise and validate specific sound signatures, linking them to individual components and failure events. This application ultimately has the potential to become a novel, cost-effective condition monitoring and failure diagnostic tool; supporting the economic viability of offshore electricity generation.



Mba, D. and Rao, R. (2006). Development of Acoustic Emission Technology for Condition Monitoring and Diagnosis of Rotating Machines; Bearings, Pumps, Gearboxes, Engines and Rotating Structures. *The Shock and Vibration Digest*, Vol. 38 (10), pp 3-16.

Merchant, N. D., Witt, M. J., Blondel, P., Godley, B. J. and Smith, G. H. (2012). Assessing sound exposure from shipping in coastal waters using a single hydrophone and Automatic Identification System (AIS) data. *Marine Pollution Bulletin*, 64 (7), pp. 1320-1329.

Specifically, this coherent project provides training microbial ecology, phycology, understanding of natural resources management, next-generation sequencing and bioinformatics. Links to an industrial partner will provide additional training in commercial applications and approaches.

In addition to the host, the partner institutions, Plymouth Marine Laboratory, Camborne School of Mines and the Environment and Sustainability Institute are also of world-class reputation and will expose the student to a vibrant and stimulating research environment

Training opportunities: The PhD student will benefit from unique training opportunities across the disciplines, including

1. *CPD-registered programme on acoustics*, including acoustic emission monitoring techniques ("Seiche Course"), co-organised by the University of Bath and Seiche Measurements Ltd. This two week-long residential course will involve lecturers from different universities and industry partners, and will be directly accessible to the student, either at entry point or later. http://www.seiche.com/courses/3

2. *Hands-on training and development in underwater acoustics laboratory* at the University of Bath, testing measurement strategies and equipment in a well-controlled and calibrated environment. This training provides an excellent preparation for subsequent sea deployment activities.

3. *Hands-on training and development in marine deployment activities* at the Falmouth Bay wave offshore renewable energy test site field test site (FaBTest), incl. sea survival training;

4. Two week *internship at the Falmouth Harbour Commissioner (FHC***)** which operates the FaBTest field test site to gain an awareness of the environmental and consentual context for offshore renewable energy

5. Participation in two-week summer schools on reliability engineering and mooring systems, hosted by the University of Exeter and delivered by the Industrial Doctoral Centre Offshore Renewable Energy (IDCORE); July 2015.

6. -Participation in regular SuperGen Marine, UK Centre for Marine Energy Research (UKCMER) doctoral training workshops; the University of Exeter is a core member of this consortium.