Alyona Naberezhnykh
IDCORE Research Engineer
University of Edinburgh
a.naberezhnykh@ed.ac.uk

Characterising turbulence for tidal turbine fatigue load analysis.

Alyona Naberezhnykh, David Ingram, Ian Ashton, Weichao Shi, David Darbinyan , Calum Miller
European Marine Energy Centre, Orbital Marine Power

1. BACKGROUND

The worlds most powerful tidal turbine is now exporting power to the grid at the European Marine Energy Centre (EMEC) test site in Orkney. This presents an opportunity to learn from real deployments and to optimise device designs to ensure a balance between cost and survivability.

Turbulence is known to be a major contributor to fatigue loading [1]

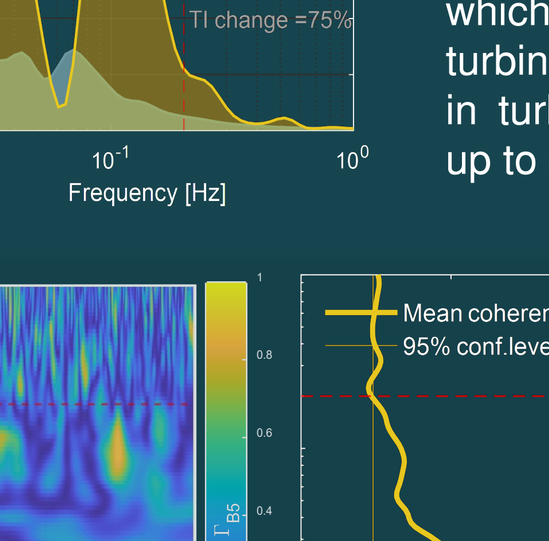
Unfortunately, tidal energy developers do not yet have robust means to understand, predict or model interactions between their devices and turbulence [2].

2. THE PROBLEM

Tidal channel turbulence is a complex, unsteady and chaotic phenomenon.

It is not well represented by simplified models, which make the assumptions of stationarity, homogeneity and isotropy, and are often based on atmospheric flows.

Velocity data from Acoustic Doppler Current Profilers is used to characterise turbulence as averaged parameters, such as Turbulence Intensity. However, these are insufficient to describe the features of turbulence important for structural loads and fatigue [3].

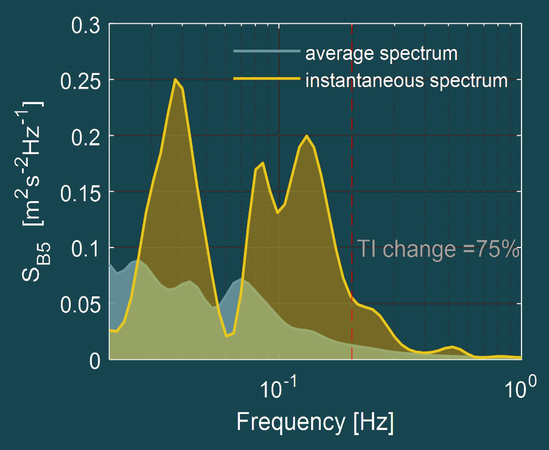


3. METHODS

This work uses novel applications of wavelet transform to analyse ADCP data and detect turbulence structures which are important for turbulence - turbine interactions

4. RESULTS

Wavelet analysis can replace the traditional Fourier methods to obtain the energy spectrum and coherence from a turbulence signal.



Wavelets allow detection of transient, energetic turbulent bursts. At the FoW test site, these can occur at frequencies which are significant tidal turbine loading, and can result in turbulence intensity increase up to 80%.

Coherency, which can only be analysed on average with Fourier methods, can be detected at each time instant with wavelets. This allows to detect the passing of large turbulent eddies in the flow.

The findings are significant for developers looking to get more from tidal site turbulence characterisation and to improve the accuracy of modelling turbulence induced loads.

The authors are grateful to EPSRC and NERC for funding for the Industrial CDT for Offshore Renewable Energy (EP/S023933/1)

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