WP3 – Modelling across scales

Aim: Confidence in models from loads through to environment

Device scale – fatigue load prediction and unsteady onset flow synthesis

- ***Benchmarking experiment and actuator model development***

Array-scale – in-wake & in-array onset flows and loading

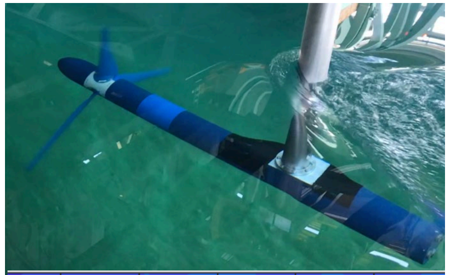
- ***Characterisation of in-array flows and model assessment***

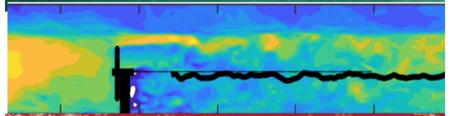
Meso-scale – array parameterisation in meso-scale models

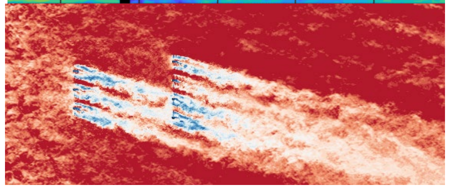
- ***Analysis of turbulence production and assessment of methods for representing arrays to model intra-array effects.***

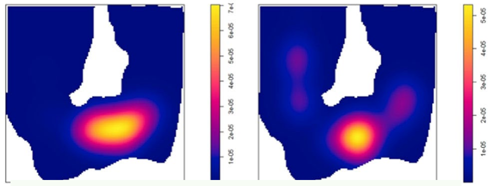
Regional scale models of population dynamics

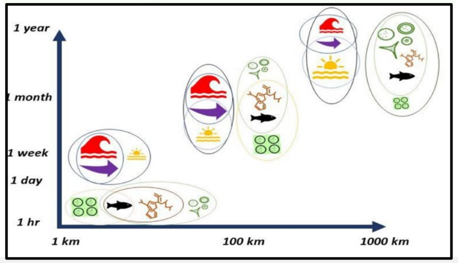
- ***Improved understanding of animal interactions with velocity & turbulence linked into ecosystem scale models using Bayesian networks***











WP3 – Modelling across scales

Device Scale through to Array Scale

Confidence in load prediction in turbulence & waves

Wake & in-wake load predictions by alternative fidelity models

Predictability of bird and fish use of velocity and turbulence.

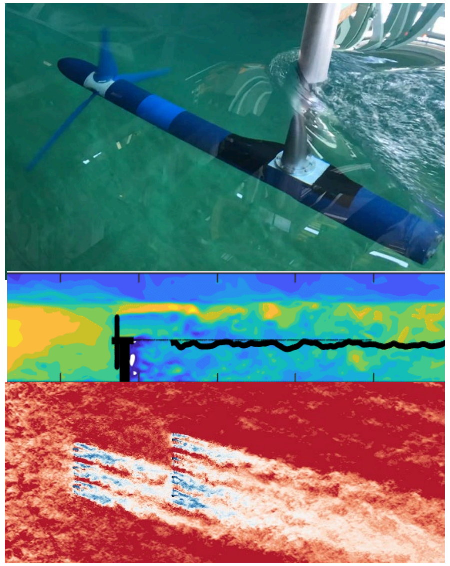
Array Scale through to Meso-Scale

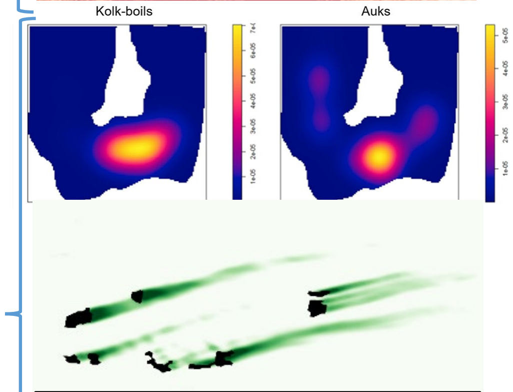
Development and assessment of turbine parameterisations for wake extent and intra-farm impacts.

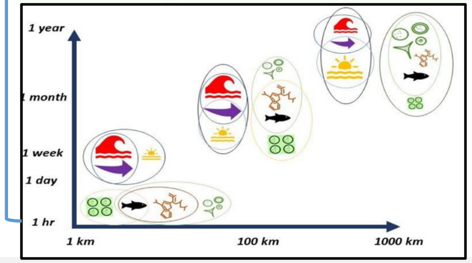
Predictability of population level changes in different habitats throughout whole ecosystems

Future Challenges:

- Validation / benchmarking for array-scale wakes
- Micro-meso-scale coupling for ecological modelling







Flex & ECR projects related to modelling

Flow measurement for accurate tidal turbine design. A. Young, Uni. Bath

LoadTide – Fatigue assessment of tidal turbine blades, J. Steynor, Uni. Edinburgh

Wave Turbulence Interaction and Measurement for Tidal Stream, A. Williams, Uni. Swansea.

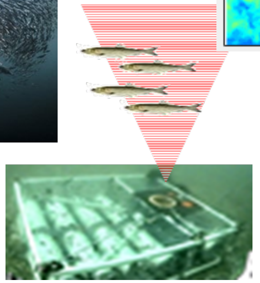
Veers' extension to non-neutral incoming winds (VENTI). M. Placidi, Uni. Surrey

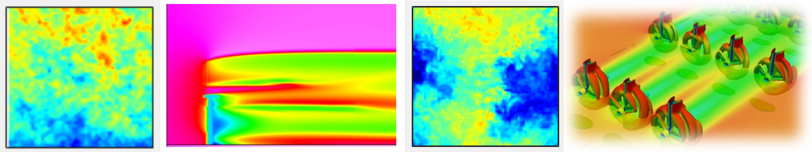
V-SCORES (**Validating Surface Currents at Offshore Renewable Energy Sites**). B. Williamson, Uni. Highlands and Islands

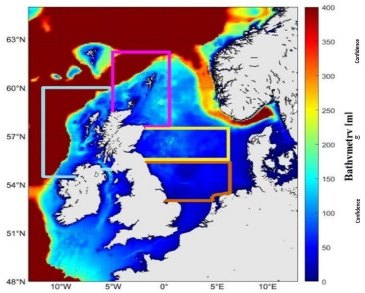
FORTUNE: Floating Offshore Wind Turbine Noise.

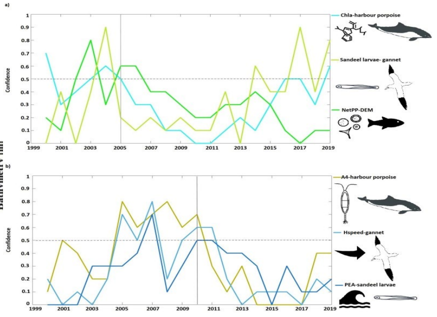
D. Risch, Scottish Association of Marine Sciences

FASTWATER: Freely-Available mesoScale simulation Tool for Wave, Tides and Eddy Replication. B. Sellar, University of Edinburgh









Novel adaptions of conventional approaches to record seabird behaviour and fish communities in tidal stream environments. J. Waggitt, Bangor Uni.

Proving a robust approach to assess bio-physical interactions with floating tidal turbines. L. Lieber, QUB.

Anisotropic blockage for tidal turbines (AnisoTide), J. McNaughton, U. Oxford.

Complex fluid dynamics involved in tidal and wind farms. P. Ouro, Uni. Manchester

WP3 – Unsteady Tidal Turbine Benchmarking Project

Rationale:

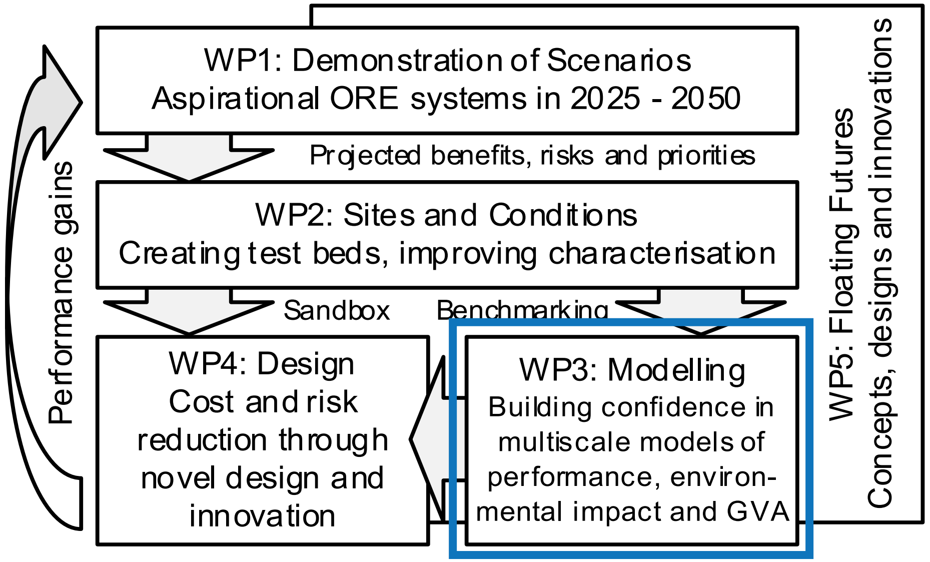
Unsteady loading and the inability to confidently predict unsteady loading and / or quantify errors drives unnecessary redundancy and design conservatism

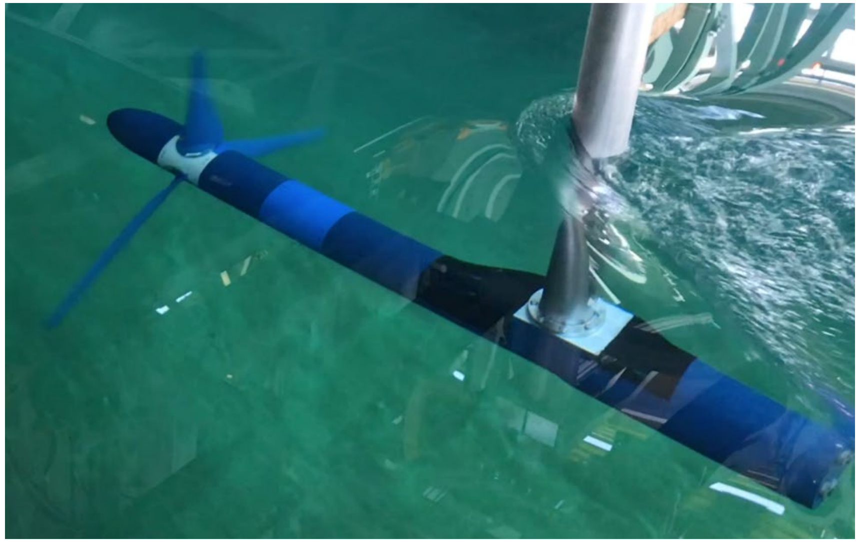
Objectives

- ***improve accuracy*** of modelling techniques,
- improve confidence in the use of modelling techniques,
- ***quantify modelling errors*** for different techniques under different loading scenarios,
- development of novel measurement techniques.

Approach

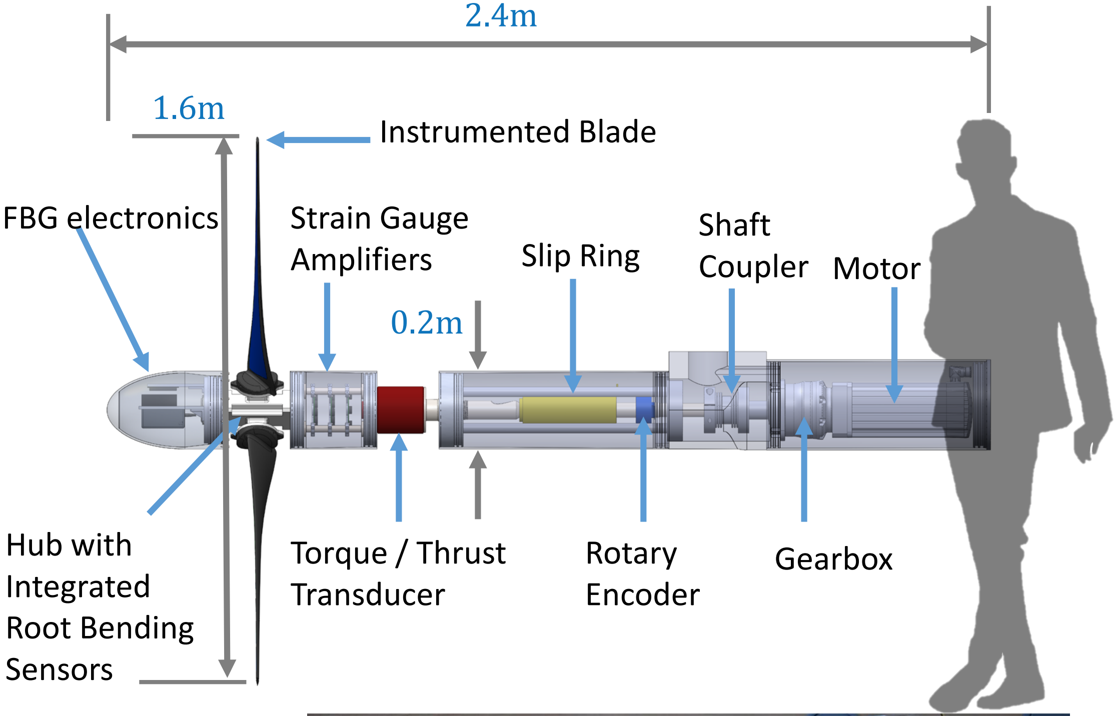
- Conduct a ***large laboratory test*** of a highly instrumented tidal turbine in waves and turbulent current to provide underlying data,
- Conduct a series of community wide (academia and industry) ***blind prediction exercises*** with staged data release, leading to an open access dataset

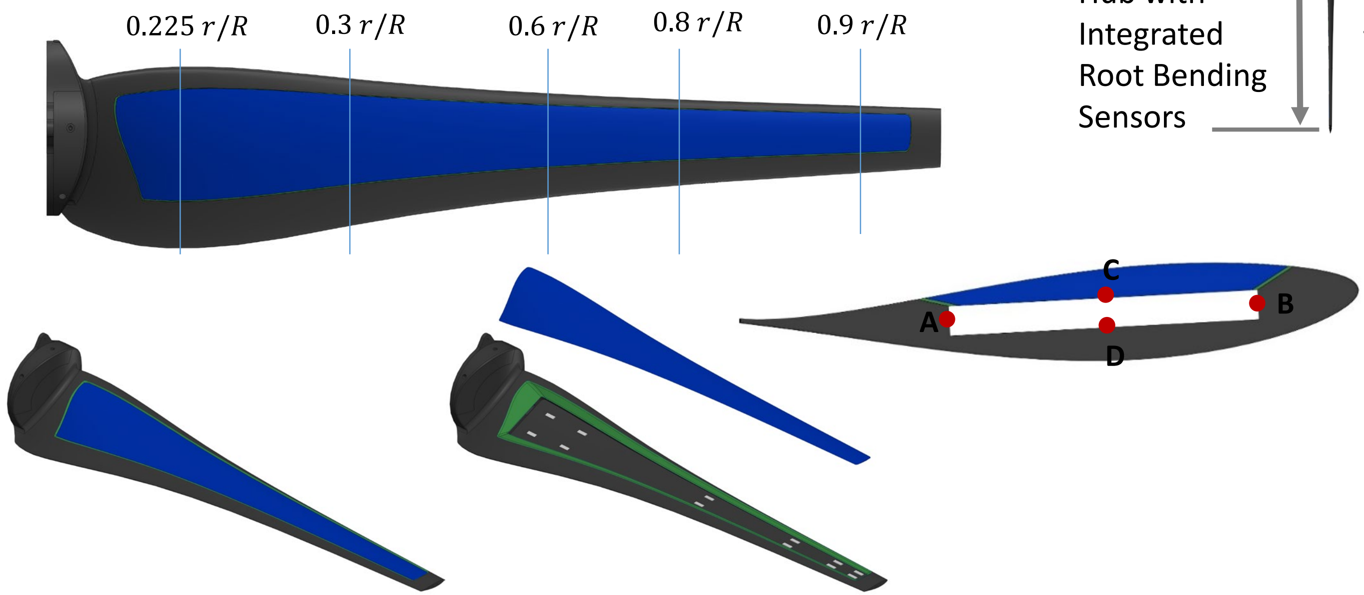


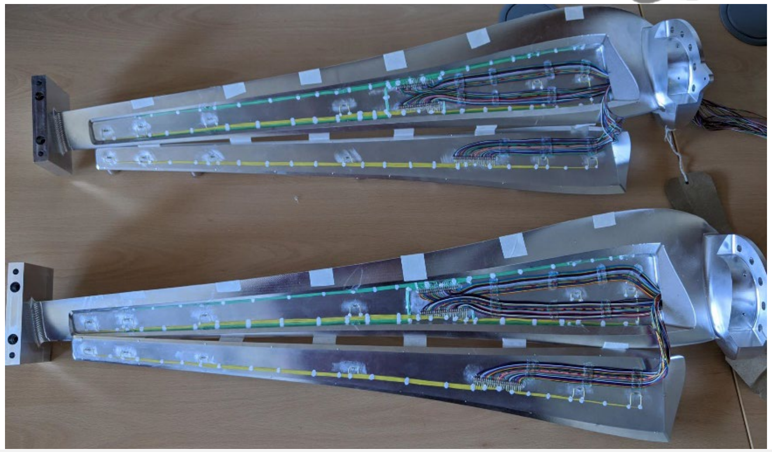


WP3 – Instrumented Test Turbine

- 3 instrumented blades (2 with strain gauges, 1 with Fibre Bragg) at six radial locations in both edge and flap directions. Total of 100 strain gauges.
- Torque and Thrust measured by shaft mounted transducer upstream of front bearing.
- Motor and encoder on high speed side.







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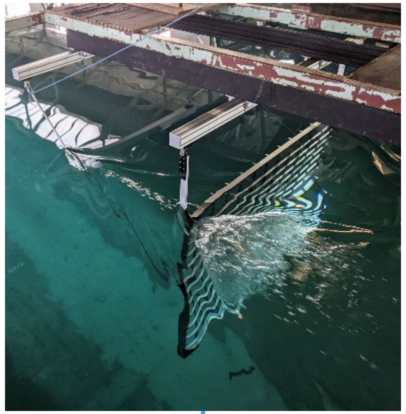
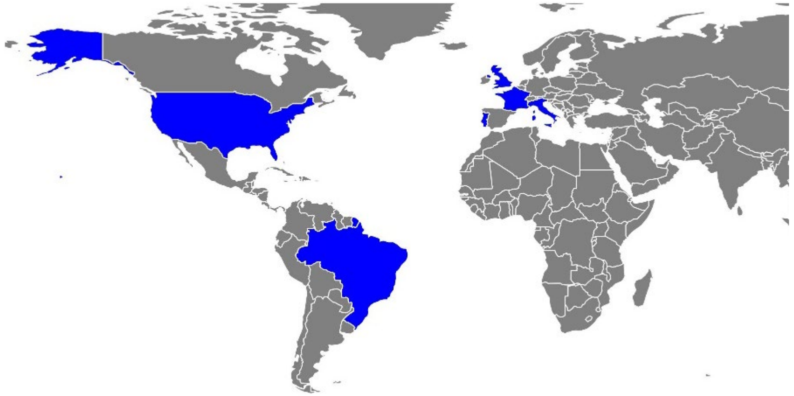
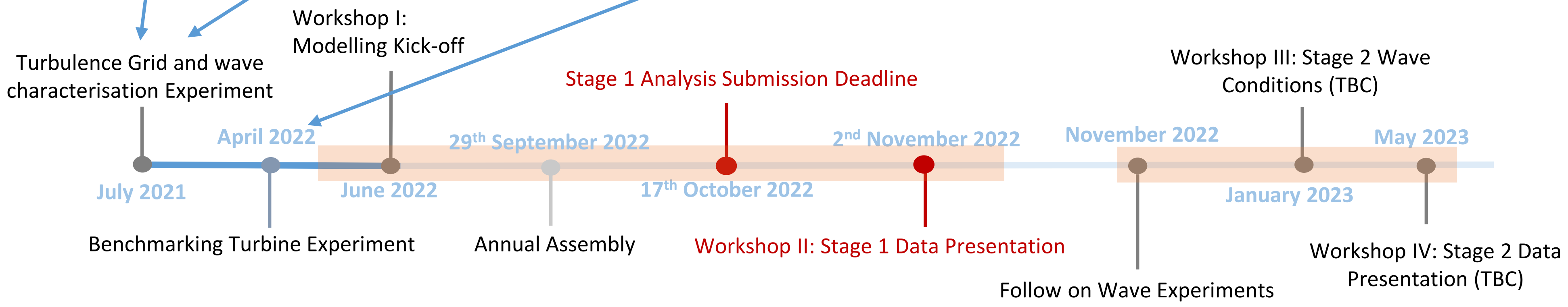
WP3 – Timeline and Participation





- **Stage I simulation stage in progress**
- 29 active participants from 6 countries
- Range of modelling methodologies: BEM, BEIM, Actuator Disk, Vortex Panel Methods, Actuator Line – RANS/LES, Blade Resolved – RANS/URANS/DES.



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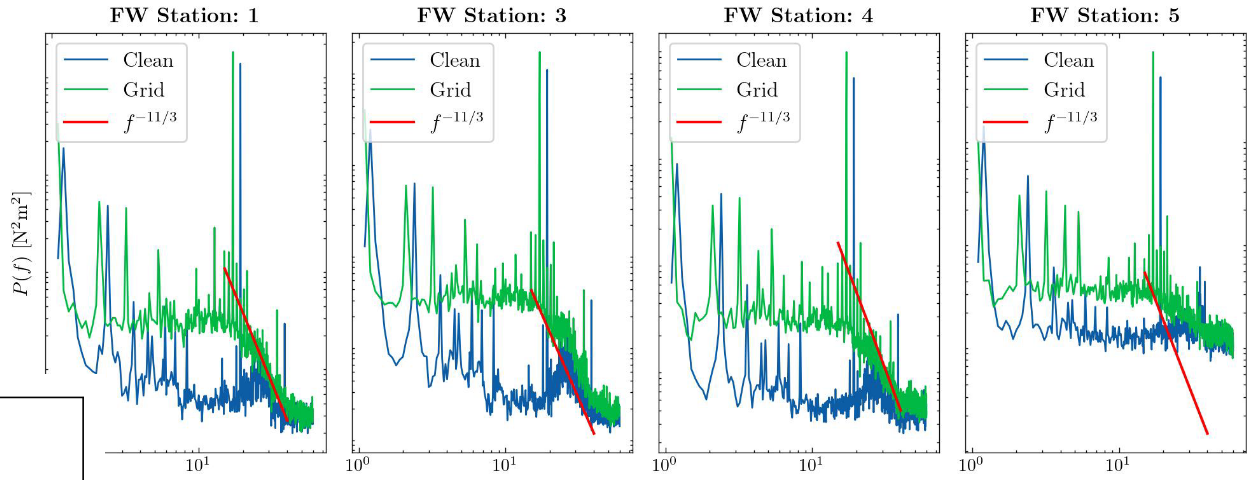
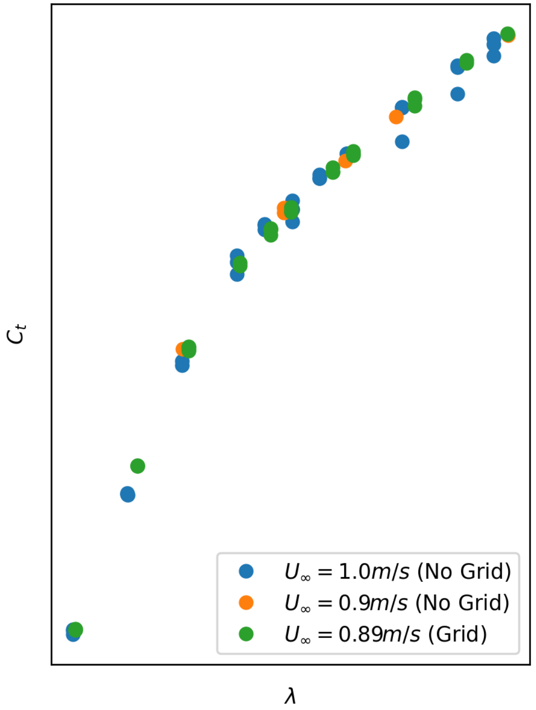
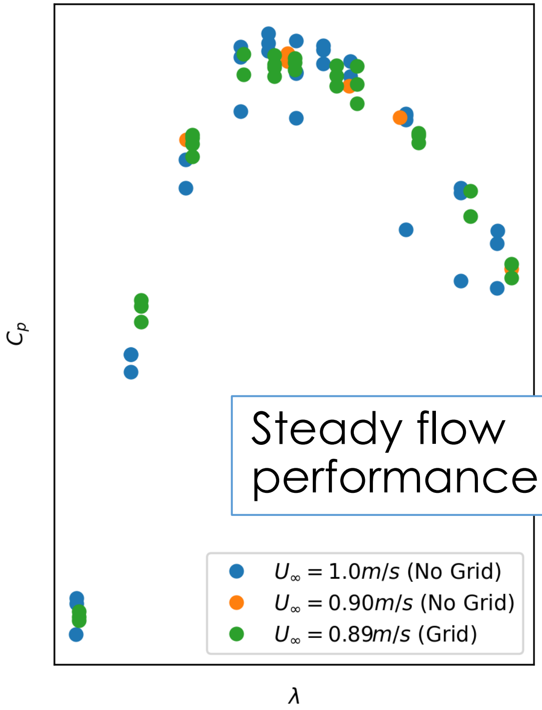
WP3 – Turbine data

- Unsteady Loading Data Set
- Unique data set with time series variation of in-blade loads in current and head waves.
- All data will be made open-access following benchmarking exercises.

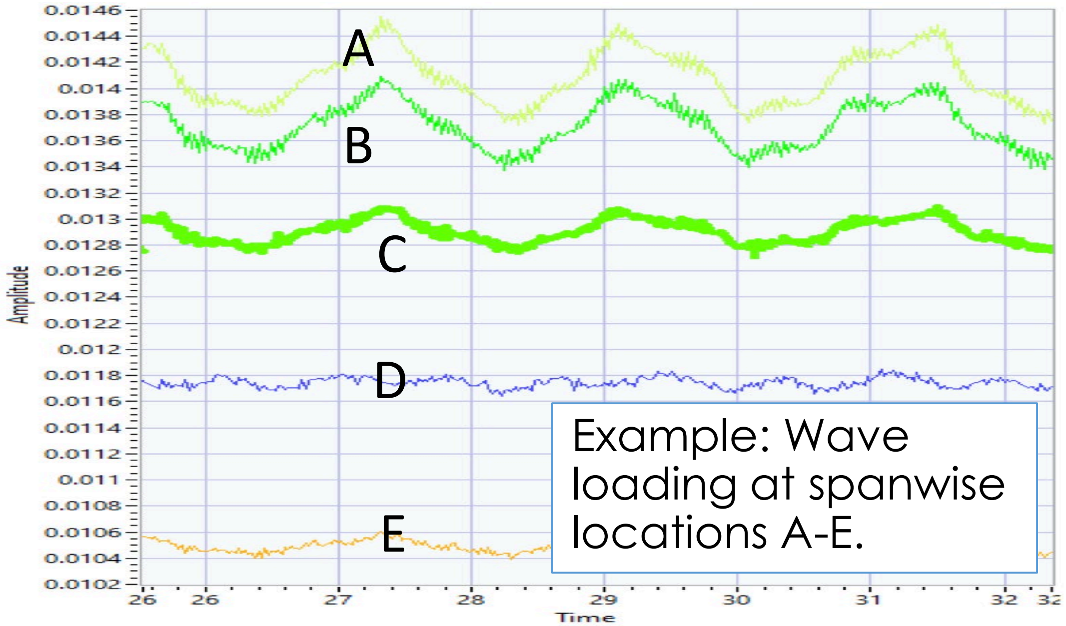
Example: Impact of grid turbulence on flapwise loads.







Steady flow performance.



Example: Wave loading at spanwise locations A-E.

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