Novel Approaches for Physical Model Testing of Floating Wind Turbine Platforms: Summary

Background:

- *Importance of correct representation of coupling between unsteady aero- and hydrodynamic forces on FOWTs*
- *Scaling challenges for Aero- Hydrodynamic forces in model tests*
- *Development of "Hybrid" model testing" (or "Software in the Loop"/SIL) simulating wind loading in physical model via software-controlled actuators…*
- *Potential benefits in cost/size of models, scaling complex behaviour, range of feasible test cases*

Challenges:

- *Highly unsteady non-linear coupling between aero and hydro effects*
- *No standard procedures for validation & uncertainty estimation*
- *Lack of understanding of cost-benefit of different approaches*
- *Full SIL requires customised versions of standard codes (e.g. FAST)*
- *Latency issues during data exchange between physical model and numerical simulation*

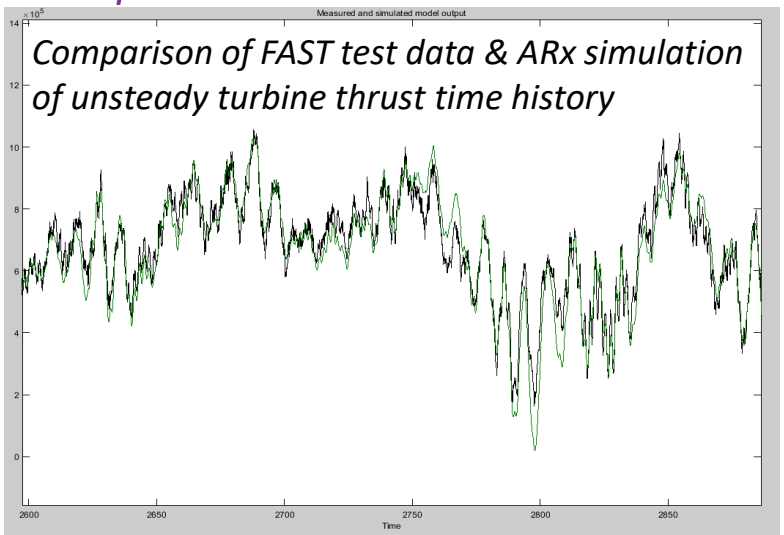
Project Aims:

- *Quantify benefits of using SIL and other hybrid testing approaches in testing of FOWT platforms*
- *Develop methodology and associated hardware for benchmarking performance of hybrid testing approaches*
- *Determine impact of system performance on simulation fidelity and uncertainty*
- *Develop metamodels for wind load simulation and test performance against "full" SIL approach*

Novel Approaches for Physical Model Testing of Floating Wind Turbine Platforms: Key Deliverables

Numerical Study of MetaModels

- *Test cases for platform motions & turbine thrust for regular/irregular waves, & steady/turbulent wind were developed using OpenFAST & used to train a range of modelling approaches & explore simulation accuracy*
- *Several models tested had some success. The ARx approach was selected for further study due to good accuracy and ease of practical implementation*



Comparison of FAST test data & ARx simulation of unsteady turbine thrust time history

Validation Study

- *ARx model implemented & tested on a 6-DOF motion platform; platform motions thus decoupled from thrust simulation, to allow direct comparison with FAST data.*
- *Motion measured using optical motion capture; turbine thrust generated by a fan driven from a real-time Labview control system.*
- *Measured thrust was compared with the FAST simulation.*
- *Good agreement shown with target with negligible latency.*

Practical demonstration

- *A series of comparative studies were carried out using an existing 74th scale model of the OC3 spar.*
- *Results (e.g. pitch RAO below) show unsteady turbine aerodynamics significantly impacts platform motions & that the ARx model successfully reproduced the aero-hydrodynamic coupling.*