

Analysis of the Near Wake of a Horizontal Axis Tidal Turbine

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 Work stream 1: Numerical and physical convergence

Project Outline

Combined numerical and experimental investigation of the near flow field of a horizontal axis tidal turbine.

Region is highly complex and dependant on a number of factors.

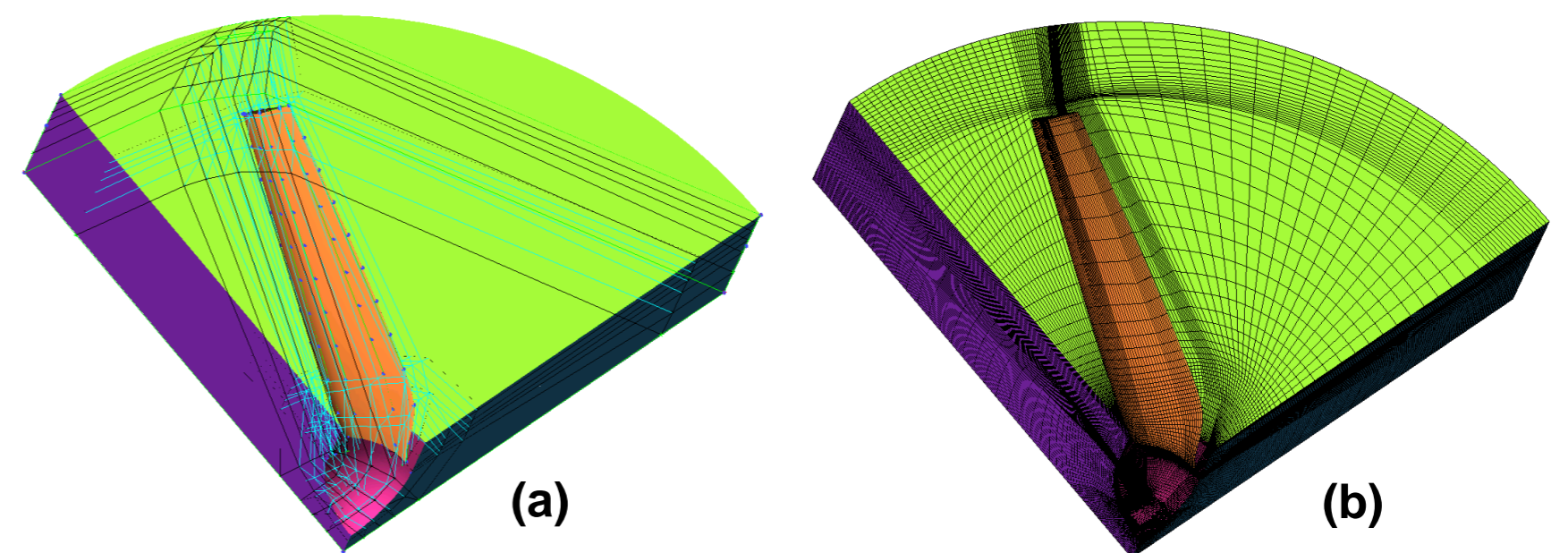
Use of computational fluid dynamics (CFD) and particle image velocimetry (PIV) to provide validated numerical models of the wake downstream of a laboratory scaled turbine.

Key area of interest is scale. The CFD models will eventually be used to simulate the wake of larger devices, for which experiments are difficult, time consuming and extremely expensive.

CFD Modelling

RANS CFD modelling (using ANSYS-CFX) of the PIV tests below. A systematic modelling approach is underway involving sensitivity studies of all model parameters. A medium density blade passage mesh is shown below.

Hexahedral meshing of rotor (a) Block topology (b) Surface mesh



PIV Experiments

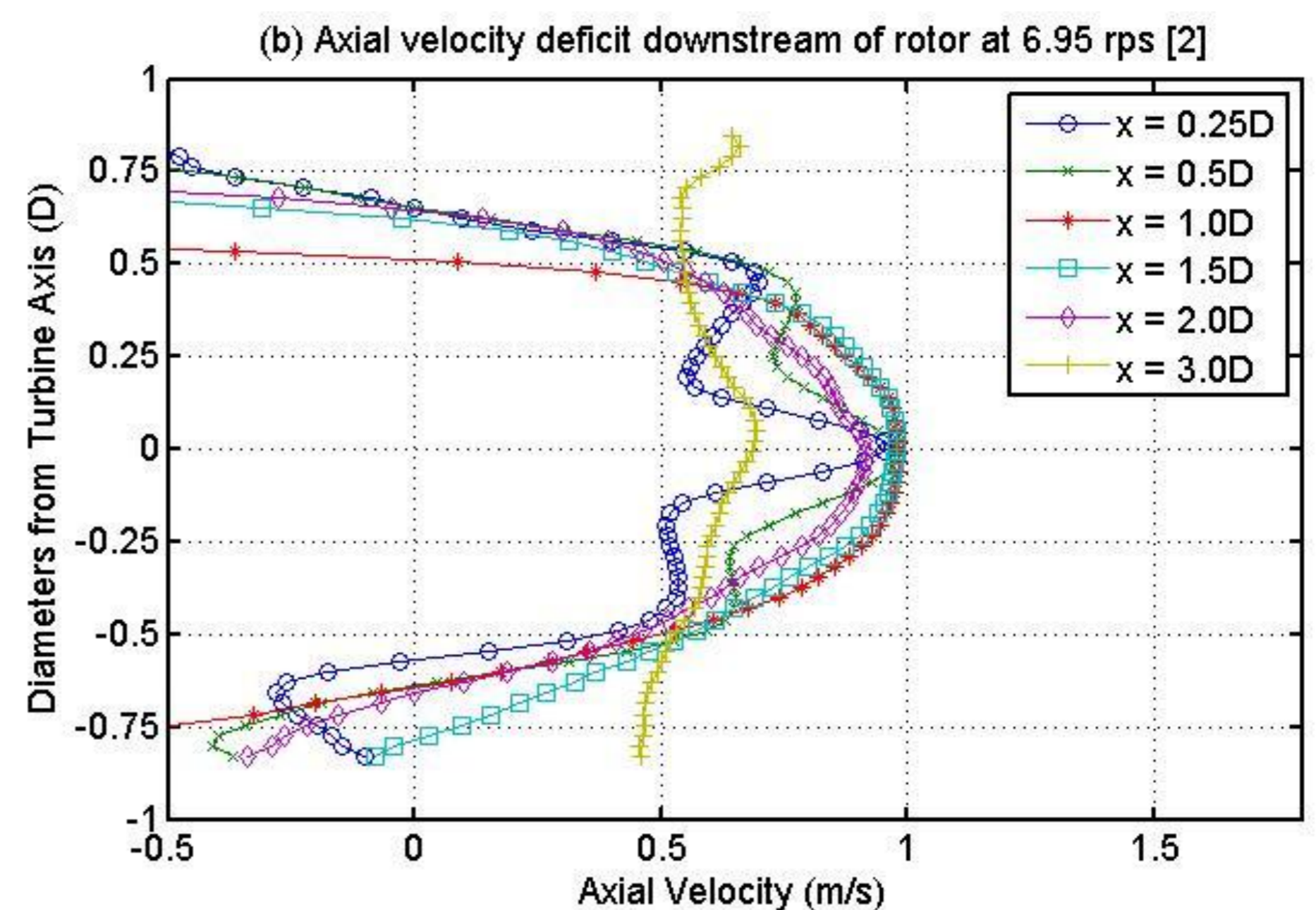
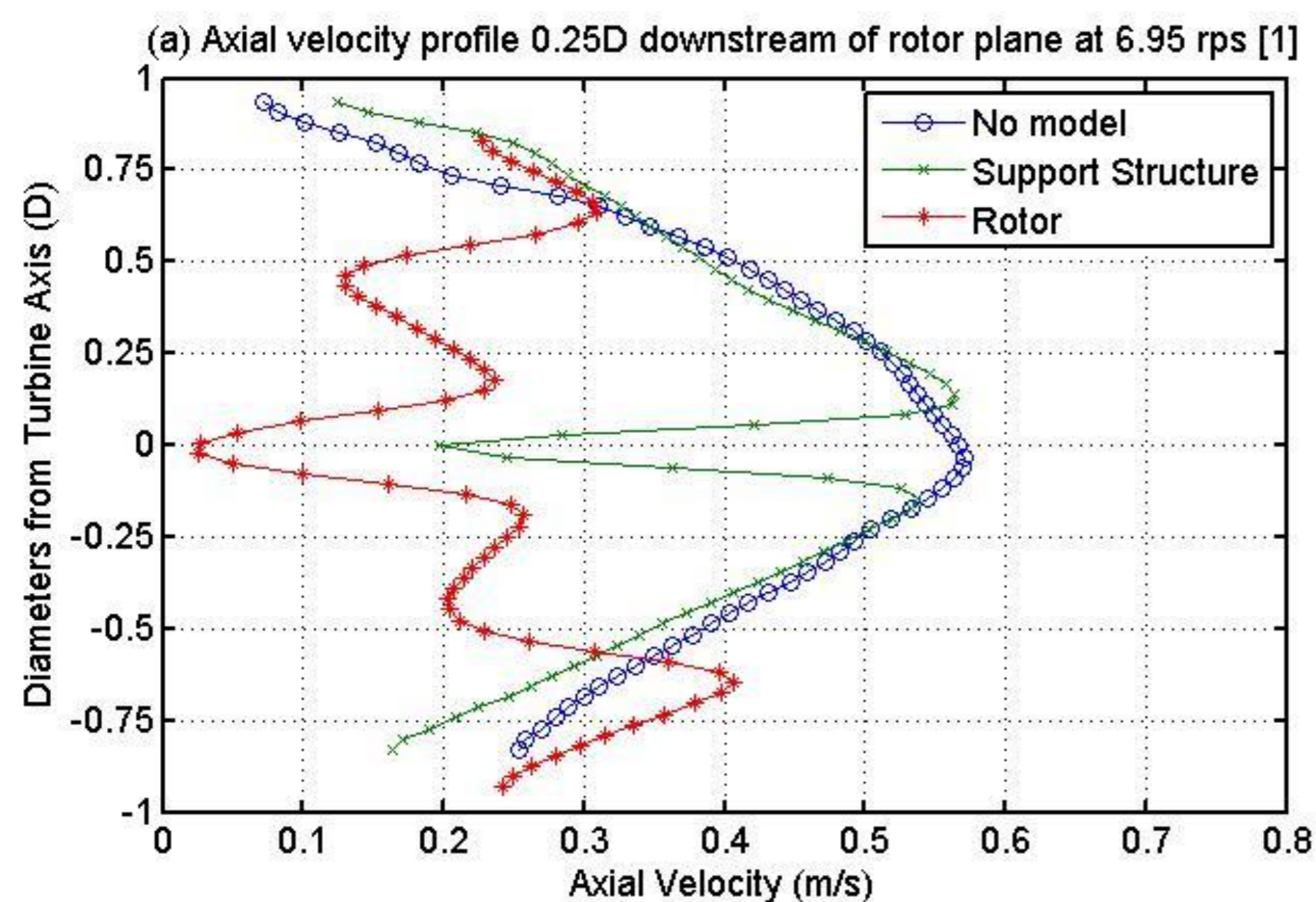
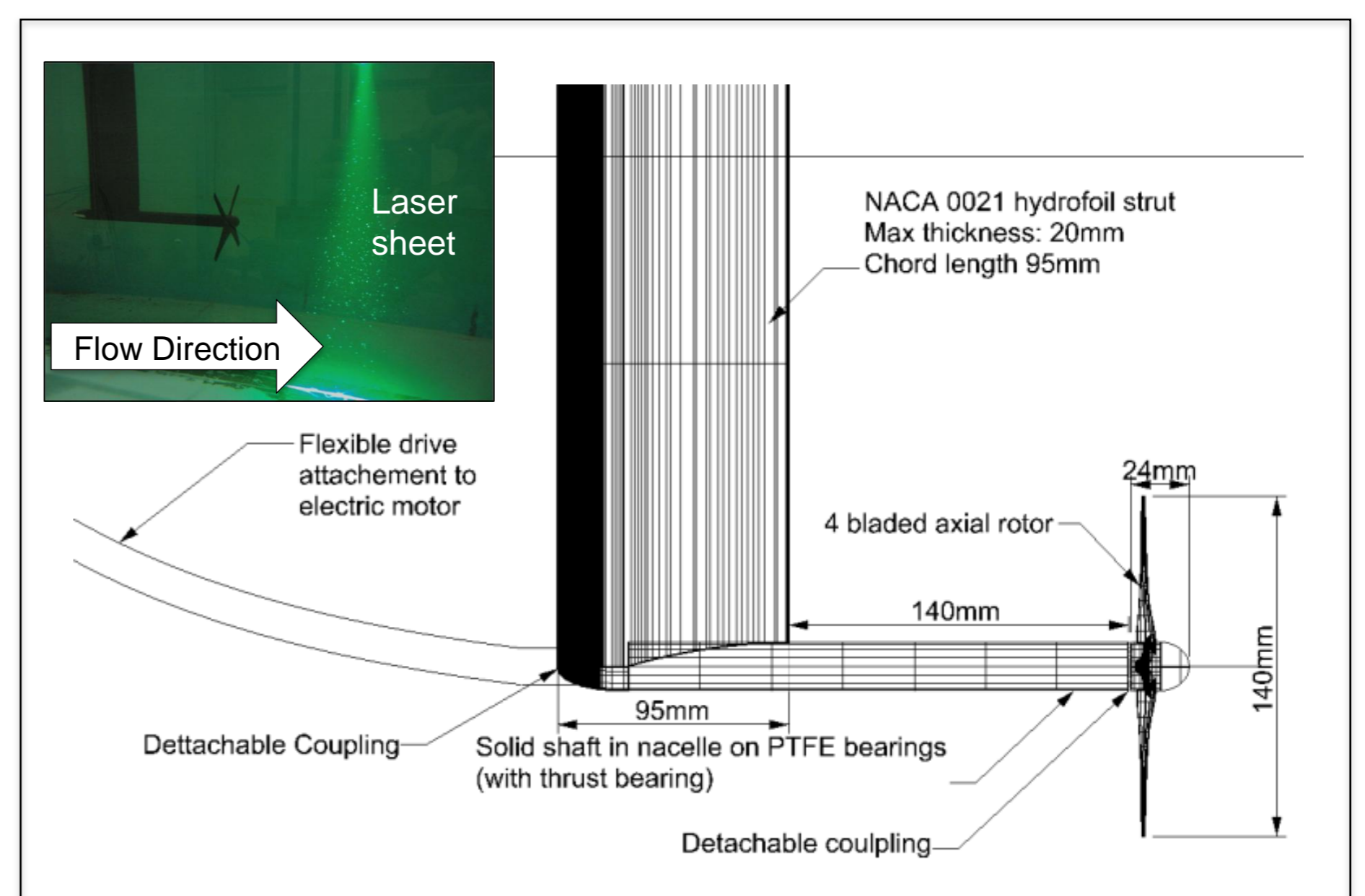
Outline (right)

- 140mm Φ model in laboratory flume
- Velocity measurements within wake by PIV
- Drive mechanism allows testing over a range of TSR (λ)
- Testing under a range of inflow velocity profiles
- Various arrangements:
 - No model
 - Support structure only
 - Range of rotational speeds

Preliminary results (below)

- (a) The plot shows the lesser impact of the support structure on axial velocity than that of the spinning rotor.
- (b) The plot shows how the axial velocity deficit is seen to recover with distance downstream.

Schematic and photograph of experimental set up (inset)



References

- [1] A. Good, G. Hamill, T. Whittaker, D. Robinson (2011), *PIV Analysis of the Near Wake of a Tidal Turbine*, Proc. 21st International Offshore (Ocean) and Polar Engineering Conference, Maui. [2] S. Rose, A. Good, M. Atcheson, G. Hamill, C. Johnstone, P. Mackinnon, D. Robinson, A. Grant, T. Whittaker (2011), *Investigating Experimental Techniques for Measurement of the Downstream Near Wake of a Tidal Turbine*, Proc. 9th European Wave and Tidal Energy Conference, Southampton.