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Tidal turbine wake characterization with vessel-mounted ADCP campaign

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Introduction

- For large tidal projects, the impact of energy extraction by the planned tidal energy converters must be assessed at the fam's scale in preliminary studies. However, there is a lack of reliable *in situ* data to calibrate and validate the models commonly used for this purpose.
- In this TIGER-funded study, we propose an accurate method to map the wake downstream of real-scale operating tidal turbines, installed in the MeyGen project tidal site.

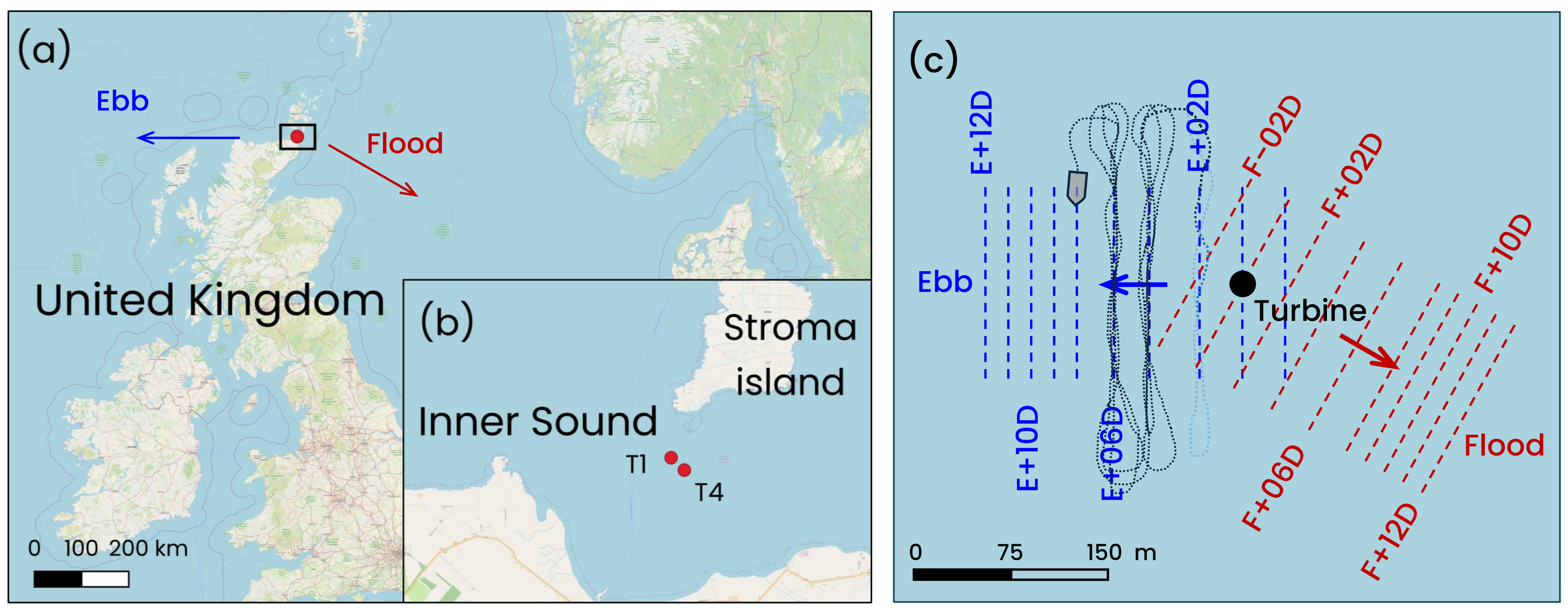

Fig. 1. MeyGen Project location within (a) the UK, (b) Pentland Firth. (c) Target transect tracks downstream of the turbine, for flood (red) and ebb (blue) events. Nominal section coordinates (dashed lines) are labelled according to the tidal stage and their distance to the turbine: "E+02D" = 2 turbine diameters downstream at ebb tide.

Results

- Velocity patterns differ when the turbine is operating and when it is turned off.
- Notably, the streamwise rotor disk averaged velocity shows a strong reduction immediately downstream of the operating turbine.
- This velocity deficit can be followed along the different cross-sections to characterize the wake deviation.

Conclusion

- A method is proposed to measure the flow in the wake of an operating tidal turbine: it proved able to finely map the flow.
- The influence of turbine operation is clearly visible in the cross-sections.
- The wake can be tracked as it moves further away from the turbine.

Measurements

- Radial velocity data were collected with a Vessel-Mounted Acoustic Doppler Current Profiler (VMADCP) during spring tides, ebb & flood.
- The turbine was successively operating and turned off.
- Series of 10 cross-flow transects were repeated 5 times each along nominal sections, defined from -02 D to +12 D in the main current direction.

Velocity solver

- The solver assigns each radial velocity measurement to a mesh cell, then solves for the mean velocity using all data points in the cell.
- "Location-based" method: velocities are combined according to their location, not their time of collection.
- Compared to conventional "time-based" solvers, the homogeneity assumption is required in a reduced sampling volume.

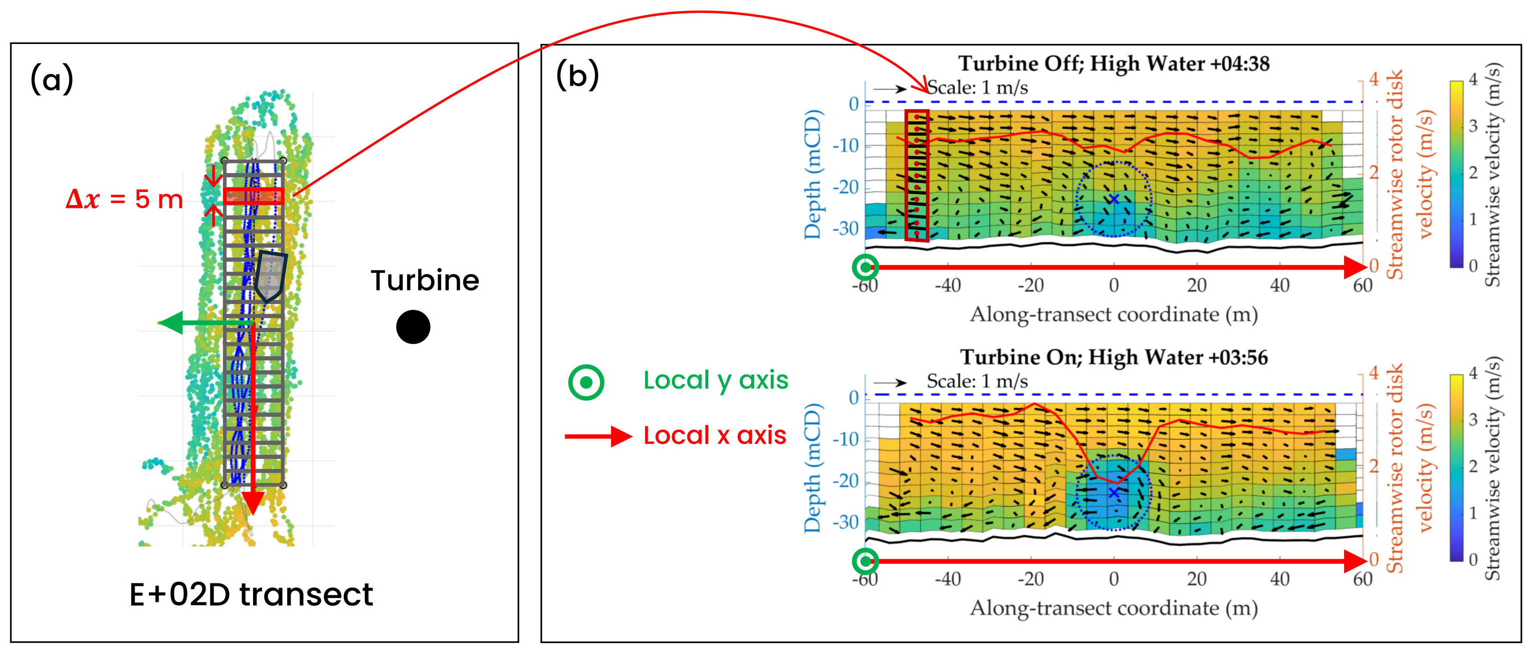

Fig. 2. Example of E+02D cross-section. (a) Data selection and mesh definition. (b) Color plot of streamwise velocity with the turbine turned off (top) and operating (bottom). Black arrows: secondary flow. Red line: rotor disk averaged velocity.

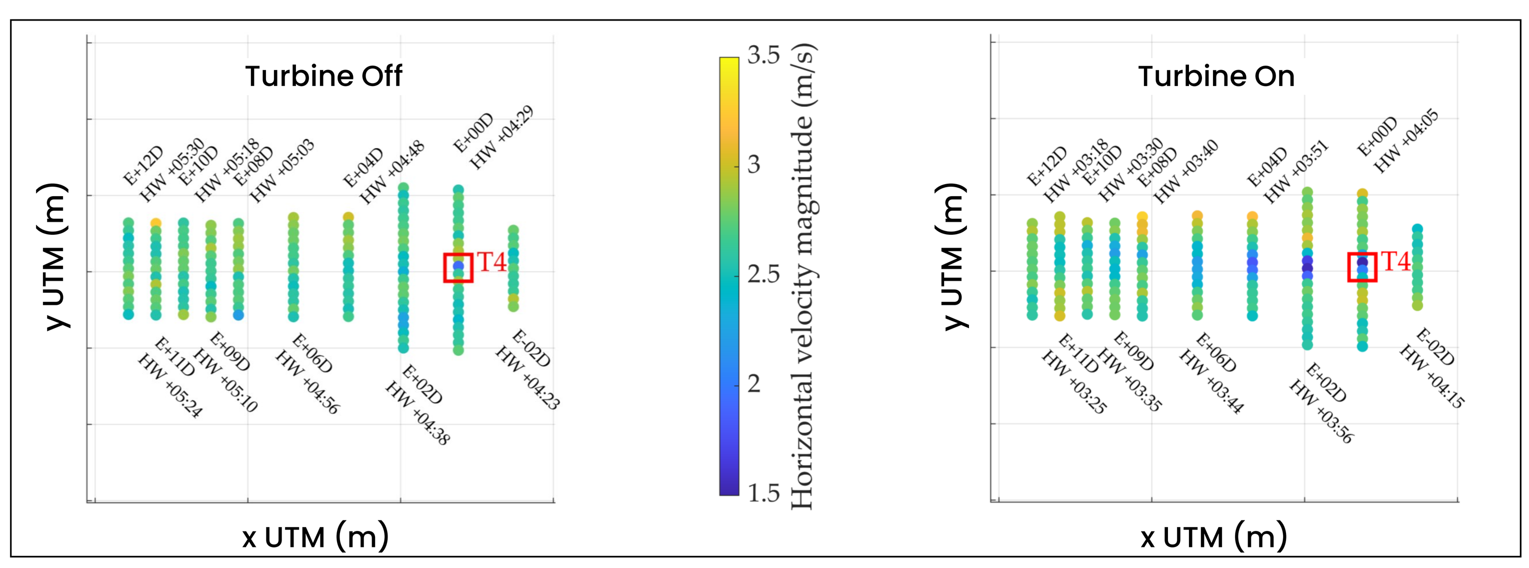

Fig. 3. Map of rotor disk averaged velocity magnitudes. Left: with the turbine off. Right: with the turbine operating. Red square indicates the turbine's position.

References

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