Modelling Complex Blade Kinematics in Cross-Flow Turbine Simulations

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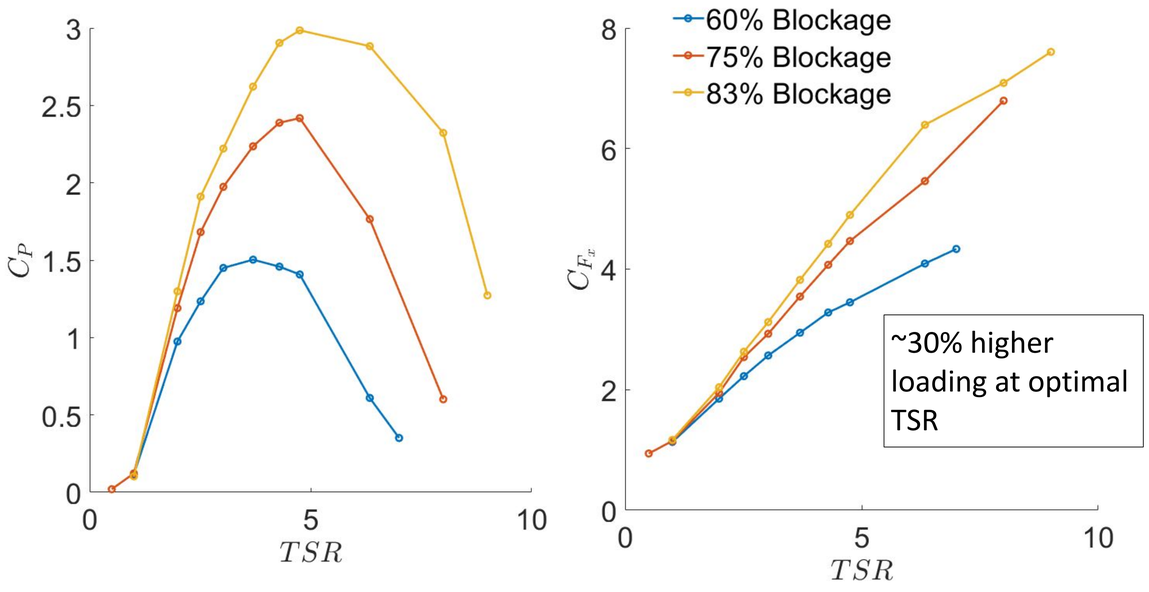
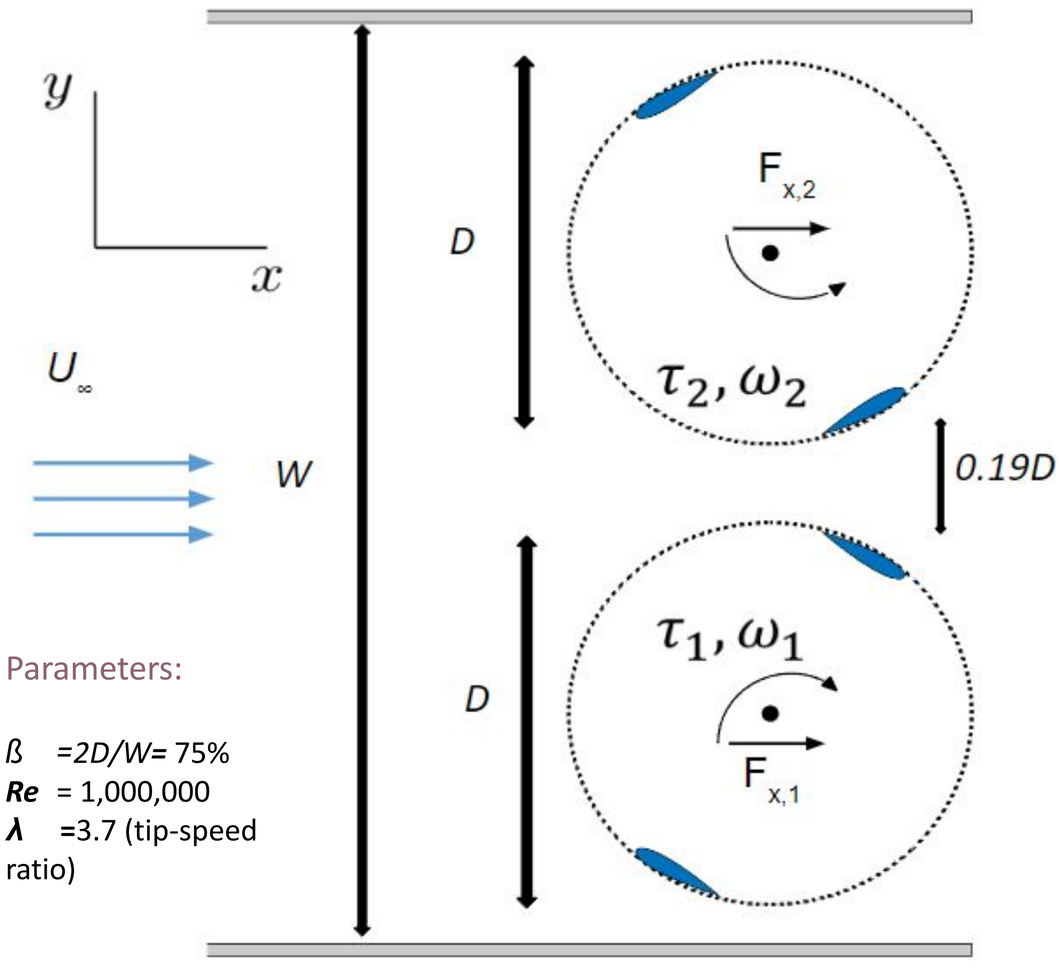
Introduction





The ARPA-e SHARKS project focuses on confinement of counter-rotating **cross flow turbine CFT** arrays, demonstrating increased performance but significantly higher loading.Given the high loading, **fluid-structure interaction** (**FSI**) analysis is crucial to understand how blade deformations impact turbine efficiency and flow patterns.

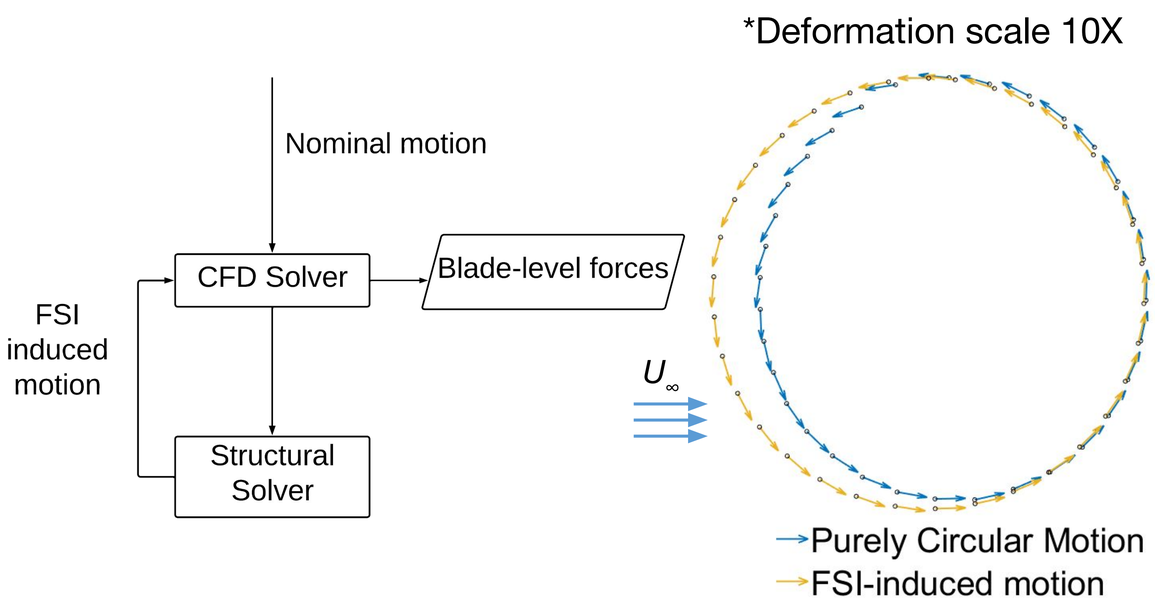
Objective: This research aims to investigate and quantify the effects of FSI-induced deformations in blade paths, on turbine performance and flow dynamics.

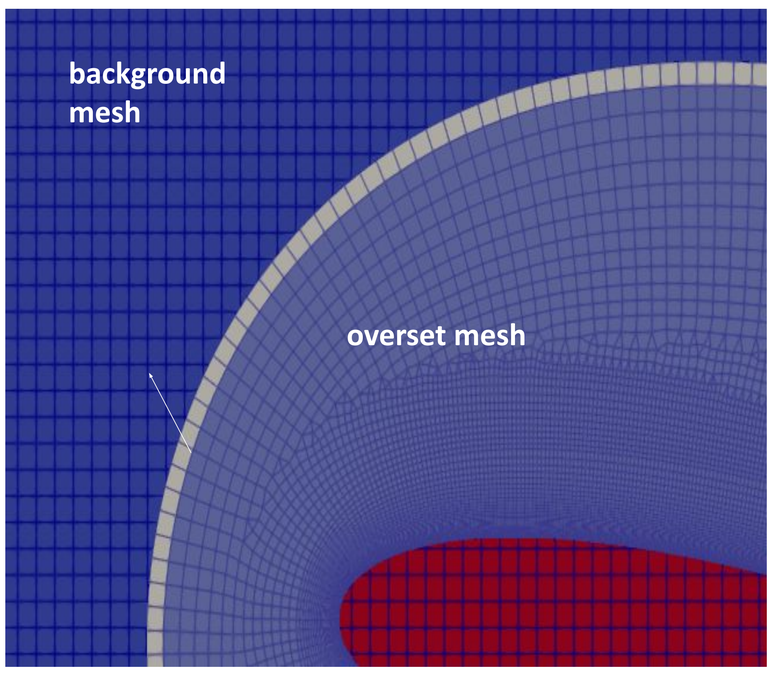
Parameters:

ß =*2D/W*= 75%
Re = 1,000,000
λ =3.7 (tip-speed ratio)

Methods

A one-way FSI coupling model based on CFD with an FEM model approach is employed to map pitch and heave deformations of the blades under loads.



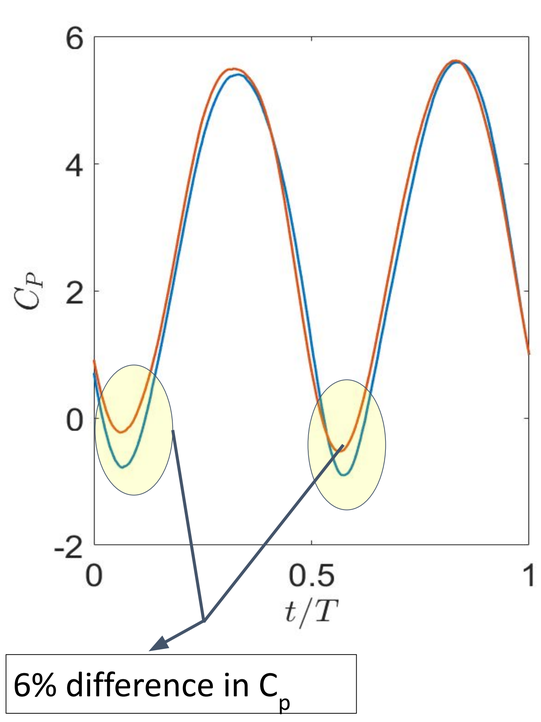


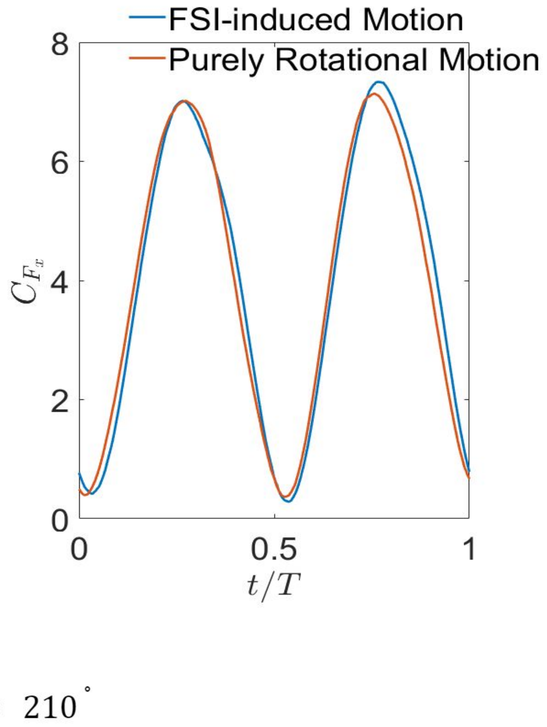
Overset meshes are optimal because:

- can handle complex kinematic profiles
- maintain good accuracy

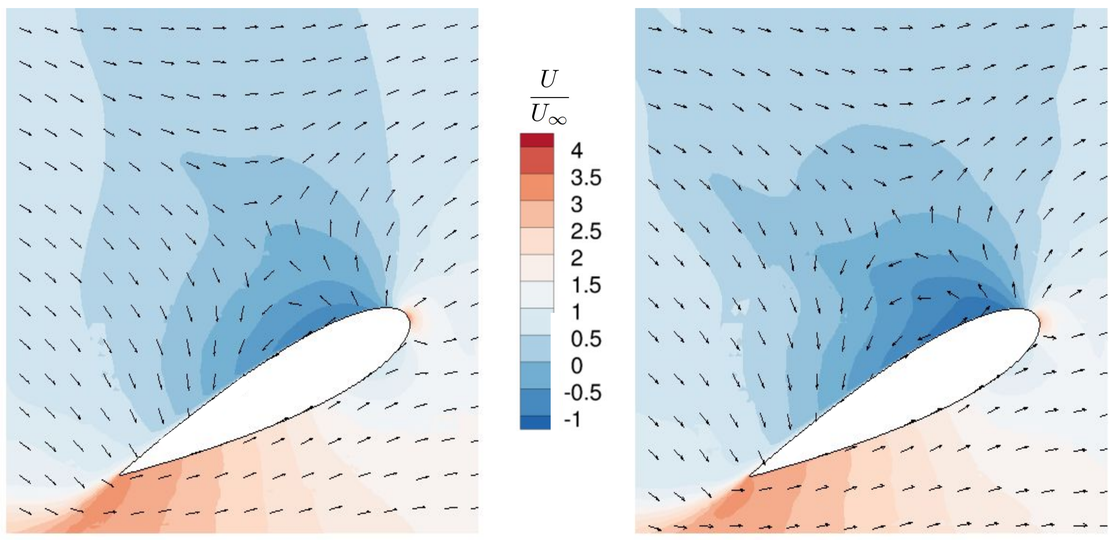
Traditional meshing strategies(sliding meshes, immersed boundary)each fail to meet at least one of these requirements

Results





$\theta \approx 210^\circ$



Purely Rotational FSI-Induced

- ~6% difference in power produced in a cycle due to difference in wake-foil interactions
- Minor changes in turbine input can cause noticeable differences in in flow physics, affecting turbine performance

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For detailed info about project, please scan the QR code!