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Vortex wake interactions and energy harvesting from tandem pitching and heaving hydrofoils[1] YUNXING SU, JENNIFER CARDONA, MICHAEL MILLER, SHREYAS MANDRE, KENNETH BREUER, Brown University — Measurements of flow structure and power extraction by tandem pitching and heaving hydrofoils are conducted in a flume. The leading and trailing hydrofoils are synchronized and aligned parallel to the oncoming flow. Force measurements and time-resolved PIV are used to characterize the system. The system efficiency of tandem foils with the same kinematics is quantified as a function of the phase difference between the foils and there exist favorable and unfavorable phase angles and that system efficiencies can be as large as 0.45. For unfavorable phase angles, PIV indicates that the leading edge vortex generated by the trailing foil, which is critical to good energy harvesting, is weakened by the oncoming wake from the leading foil. Conversely, at a favorable phase, the vortex shed from the leading foil enhances the performance of the trailing foil, compensating for the otherwise negative aspects of operating in the wake. A model, combining frequency, separation distance and a characteristic convection velocity, is introduced to predict the optimal phase region and is validated over a range of parameters. By changing the pitching amplitude and phase angle in trailing foil we show that relatively larger pitching amplitudes can further improve the system efficiency.

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