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Spanwise visualization of the flow around a three-dimensional foil with leading edge protuberances M.J. STANWAY, A.H. TECHET, MIT — Studies of model humpback whale fins have shown that leading edge protuberances, or tubercles, can lead to delayed stall and increased lift at higher angles of attack, compared to foils with geometrically smooth leading edges. Such enhanced performance characteristics could prove highly useful in underwater vehicles such as gliders or long range AUVs (autonomous underwater vehicles). In this work, Particle Imaging Velocimetry (PIV) is performed on two static wings in a water tunnel over a range of angles of attack. These three- dimensional, finite-aspect ratio wings are modeled after a humpback whale flipper and are identical in shape, tapered from root to tip, except for the leading edge. In one of the foils the leading edge is smooth, whereas in the other, regularly spaced leading edge bumps are machined to simulate the whales fin tubercles. Results from these PIV tests reveal distinct cells where coherent flow structures are destroyed as a result of the leading edge perturbations. Tests are performed at Reynolds numbers $Re \sim \mathrm{O}(10^5)$, based on chordlength, in a recirculating water tunnel. An inline six-axis load cell is mounted to measure the forces on the foil over a range of static pitch angles. It is hypothesized that this spanwise breakup of coherent vortical structures is responsible for the delayed angle of stall. These quantitative experiments complement exiting qualitative studies with two dimensional foils.

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