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Flow Measurements of a Plunging Wing in Unsteady Environment. JESSE WENGEL, RUNGUN NATHAN, BO CHENG, AZAR ESLAM-PANAH, Penn State University — Despite the great progress in their design and control, Unmanned Aerial Vehicles (UAVs) are tremendously troubled while flying in turbulent environments, which are common in the lower atmospheric boundary layer (ABL). A nominally 2D plunging wing was developed and tested in the presence of unsteady wake to investigate the effect of the flow disturbances on vorticity fields. The experiments were conducted in a water channel facility with test section width of 0.76 m, and a water depth of 0.6 m. The unsteady wake in the form of von Kármán Vortex Street was generated by a cylinder located upstream of the plunging wing. The plunge amplitude and frequency of the oscillation were adjusted to bracket the range of Strouhal numbers relevant to the biological locomotion ($0.25<St<0.35$). Free-stream velocity is held constant at 0.13 m/s for all the cases, producing a chord-based Reynolds number of 10,000. These cases were selected because there is a significant lack of knowledge describing the topology of the flow field in presence of upstream vortical structures. First, the dye flow visualization technique was used to qualitatively observe the wake behind the cylinder, mainly to position the wing with respect to the upstream vortical structure. Second, time-resolved Particle Image Velocimetry (PIV) was employed to quantitatively study the effect of unsteady wake on the flow measurements of the plunging wing.

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