Abstract Submitted
for the DFD08 Meeting of
The American Physical Society

Lift force time delays on 2D and 3D wings in unsteady flows[1]
DAVID WILLIAMS, JESSE COLLING, VIEN QUACH, Illinois Institute of Technology, TIM COLONIUS, California Institute of Technology, GILEAD TADMOR, Northeastern University — Active flow control (AFC) used for enhancing the maneuverability of wings is usually applied during conditions of steady external flow. However, when the external flow is unsteady or the wing is maneuvering, then at least two time delays become important; namely, the time delay of the lift to changes in external flow, τ_f, and the time delay to changes in AFC actuation, τ_a. These time delays were measured in wind tunnel experiments using two- and three-dimensional wings in an oscillating freestream and with variable duty cycle actuation. Dimensionless freestream oscillation frequencies from k = 0.01 to k = 0.2 with amplitudes of 5 percent of the mean speed were used to characterize the system. As a demonstration of the important role of the two time constants, AFC is used to damp lift force oscillations occurring in an unsteady freestream using a feed forward control system. The instantaneous velocity provides input to a control algorithm which adjusts the duty cycle of the AFC actuator to suppress lift fluctuations.

[1]Supported by AFOSR MURI FA9550-05-1-0369 with program manager Dr. Fariba Fahroo.

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Date submitted: 06 Aug 2008 Electronic form version 1.4