Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Thrust Estimation for a Flapping Membrane Foil Using Control Volume Analysis GALI ALON TZEZANA, VARGHESE MATHAI, KENNETH BREUER, Center for Fluid Mechanics, Brown University — Analytic models have shown that the use of a compliant membrane may improve or impair the propulsive performance of a flapping wing, depending on the ratio between elastic, inertial, and fluid forces. However, such models are limited by assumptions of small deformations and potential flow. Therefore, it is of interest to experimentally measure the thrust produced by flapping membranes. The experimental evaluation of thrust of a flapping membrane is challenging, due to the difficulty to separate inertial forces from the small aerodynamic (or hydrodynamic) forces. Here, we use control volume analysis to estimate the thrust force generated by a heaving membrane in a water flume. Particle Image Velocimetry (PIV) measurements provide velocity data in the wake, and the velocity fluctuations are used to estimate the downstream pressure profile. We compare the results with direct force measurements, where inertial forces are subtracted, and discuss the strengths and limitations of both methods. While the mean velocity profile contains much of the information needed to predict the propulsive performance, the contribution of unsteady effects is not negligible. As the membrane compliance increases, a transition is observed in the mean wake structure, accompanied by thrust reduction.

Gali Alon Tzezana
Center for Fluid Mechanics, Brown University

Date submitted: 01 Aug 2020 Electronic form version 1.4