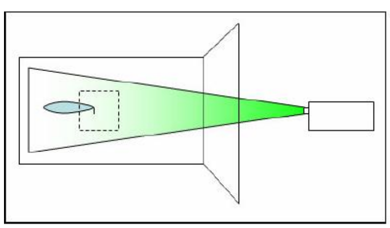
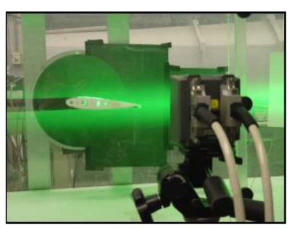
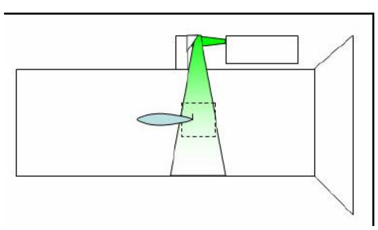
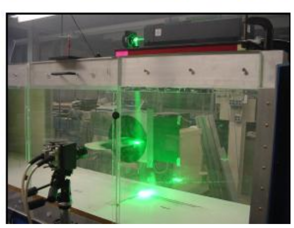
THE EFFECT OF GURNEY FLAP HEIGHT ON VORTEX SHEDDING MODES BEHIND SYMMETRIC AIRFOILS

APPLICATION NOTE PIV-010

An investigation of the influence of the Gurney Flap height on vortex shedding modes was studied using a time-resolved PIV system with the INSIGHT 3G™ software, the HS-2000 camera, and a hot-film thermal anemometry probe. The Gurney flap is a small tab approximately 1% to 4% of the airfoil chord in length that protrudes 90° to the chord at the trailing edge that is used to achieve higher lift.

TRPIV (Time-resolved PIV) measurements were made in two configurations. The first was with the laser light sheet entering from the exit of the tunnel, and the second had the light sheet entering the tunnel from above. The camera was on the side of the tunnel.

These two configurations allowed velocity information to be gleaned from the area directly downstream of the Gurney flap, as well as from the cavity directly upstream of the flap. The laser was a 30 W diode pumped Nd:YLF system, emitting light of wavelength 527 nm. The light sheet thickness was approximately 2 mm. At 2000 frames per second, the energy per pulse was 10 mJ, and at 8000 the energy per pulse was 4 mJ. The digital image sequences were acquired from a 10-bit CMOS high speed camera at rates of 2000 frames per second, 4000 frames per second, and 8000 frames per second, which correspond to velocity field capture rates of 1000 Hz, 2000 Hz, and 4000 Hz, respectively. Results from data captured at 2000 frames per second with full camera pixel resolution of 1024 by 1024 pixels, and on data captured at 8000 frames per second with pixel resolution of 1024 by 256 pixels are provided. The distance from the camera to the light sheet varied from 400 mm to 550 mm. A 50 mm lens was used with a largest aperture setting of f#1.4. The full field of view was 114 mm square. The Δt value was 35 µs, which allowed for a maximum particle displacement of 4 pixels at U = 15.89 m/s. Olive oil atomized with an array of six Laskin nozzles was used to seed the flow, providing droplets with a mean diameter between 1 µm and 3 µm.

For each run, between 50 and 500 TRPIV velocity fields were acquired. TSI software, *INSIGHT* 3G, was used to process the data. The vector fields were determined using a CDIC deformation algorithm described by Wereley and Gui (2001). This multipass method used an interrogation region of 16 by 16 pixels with 75% overlap, which corresponds to a resolution of slightly more than 2 mm. This processing scheme yielded 98% or higher valid vectors in each field.

While the size of coherent structures scaled well with the height of the flap, it was observed that the ratio of the primary to secondary shedding modes remained essentially constant, suggesting that the shedding mode ratio was independent of Gurney Flap height within the examined size range.

(Courtesy University of Minnesota–Department of Aerospace Engineering and Mechanics)

References

Troolin, D., Longmire, E. K., and Lai, W. T. , "Time-resolved PIV analysis of flow over a NACA 0015 airfoil with Gurney flap," *Experiments in Fluids*, **41**, 2006, 241–254.

Troolin, D. R., Longmire, E. K., and Lai, W. T, "The Effect of Gurney Flap Height on Vortex Shedding Modes behind Symmetric Airfoils," *13th Int. Symp. on Appl. Laser Techniques to Fluid Mechanics,* Lisbon, Portugal, June 26–29, 2006.