THREE-DIMENSIONAL PIV-BASED PRESSURE COEFFICIENT VISUALIZATION IN AIRCRAFT PROPELLERS

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ABSTRACT: Studies on modern aircraft propellers require both the visualization of the propeller slipstream[1] and the evaluation of the pressure field on the blade, especially in the acoustic and fatigue design of complex systems such as prop-fans[2]. The current investigation proposes the integration of stereoscopic PIV velocity data to obtain the pressure distribution around the blade of a DHC propeller blade running in the transonic regime (M_{Rtip}= 0.73). The stereoscopic PIV experiments were performed in the low-speed, closed-circuit low turbulence (LTT) wind-tunnel of the Aerodynamics Laboratories at the Delft University of Technology (1.8 m width, 1.2 m height, max speed: 120 m/s). Phase-locked stereoscopic PIV measurements were obtained starting from $z = 0.3\ R$ propeller radius (R = 118 mm, chord c_{max} = 19.6 mm) to the blade-tip, with the propeller running at a revolution frequency of 18,900 rpm. Based on the pressure integration from the Navier-Stokes momentum equation[3], the 3-dimensional pressure field and the surface pressure distribution are inferred from the stereoscopic phase-locked velocity fields acquired at different distance z/R.

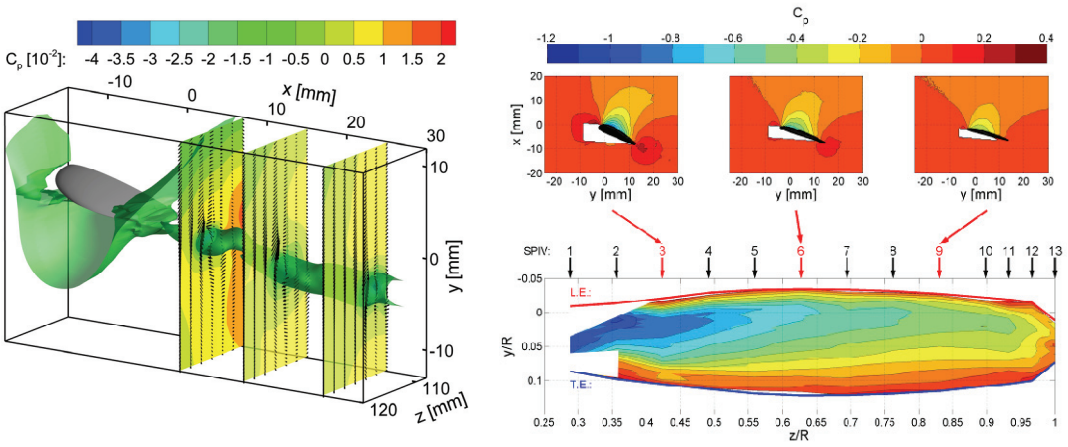

Figure 1 Left: blade-tip vortex visualization, right: PIV Surface pressure distribution on the suction-side of the blade

Figure 1-left presents a 3D visualization of the calculated pressure coefficient on the blade-tip, with iso-contours delimiting the stagnation and acceleration regions, while the surface pressure distribution is presented on the suction side of the blade in Figure 1-right.

References

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