Application of long-distance Micro-PIV at large Reynolds number

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In [1] it was demonstrated that the long-distance micro PIV technique is well suited to determine the wall-shear-stress and near-wall turbulence structure up to single pixel resolution (0.7 micrometer/Vector). To examine the potential of the recording and evaluation methods at large observation distances (up to 1300 mm) and large magnification factors (up to M=28) a separation and jet experiment was performed and the single pixel evaluation approach was extended for stereoscopic PIV.

1. Laminar separation bubble on a 2D airfoil

The aim of the first experiment was the determination of the size and shape of a laminar separation bubble and the amplification of the velocity fluctuations in the shear layer were the transition takes place. The basic problem is the small size of the separation bubble (only a few millimeters in length and 1 mm in height), the large velocity at the bubble location (150 m/s at 50 m/s free stream velocity), the flow gradients and the large observation distance (600 mm). By using a long-distance microscope (Infinity K2) with a standard front lens the field of view was 8 mm by 6 mm by using a PCO.4000 high resolution CCD camera with 4008 × 2672 pixel resolution. The lower two figures reveal the mean velocity distribution (left) and the RMS distribution (right) for the two in-plane velocity components. The flow is from left to right and the blue crosses indicate the model. The results demonstrate the capabilities of the technique for flow research in large wind tunnels.

2. Stereoscopic analysis with single pixel resolution

In the past the single pixel evaluation approach was only applied for the evaluation of conventional PIV images. To estimate all three velocity components with single pixel resolution the evaluation approach was extended. For the validation 1024 synthetic image pairs were generated with a pure 2D Rankine vortex flow. The following two figures show the effect of first and second order accuracy. In the first case (left) the streamlines are not closed circles but spirals. This systematic error vanishes when the second order approach is applied (right).

Reference


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