

Simultaneous Measurement of All the Three Components of Vorticity Vectors by Using a Dual-plane Stereoscopic PIV System

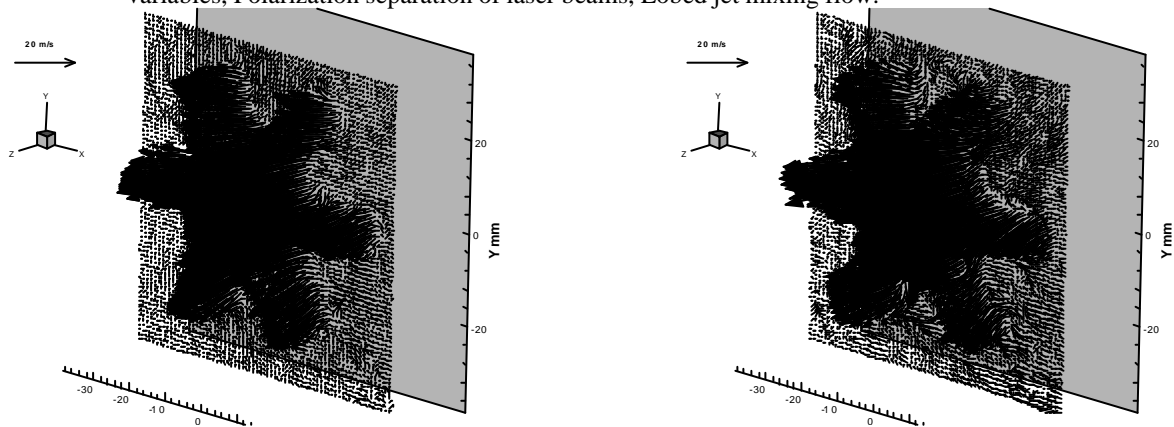
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ABSTRACT

The technical basis and system set-up of a dual-plane stereoscopic PIV system, which can obtain the flow velocity (all three components) fields at two spatially separated planes simultaneously, was described in the present paper. The simultaneous measurements were achieved by using two sets of double-pulsed Nd:Yag lasers with other optics to illuminate the objective fluid flow with two orthogonally linearly polarized laser sheets at two spatially separated planes. The scattering lights from the two illuminating laser sheets with orthogonal linear polarization were separated by using polarizing beam splitter cubes, then recorded by high-resolution CCD cameras. Unlike conventional two-dimensional PIV systems or single-plane stereoscopic PIV systems, which can just get one-component of vorticity vectors, the present dual-plane stereoscopic PIV system can provide all the three components of the vorticity vectors and various auto-correlation and cross-correlation coefficients of flow variables instantaneously and simultaneously.

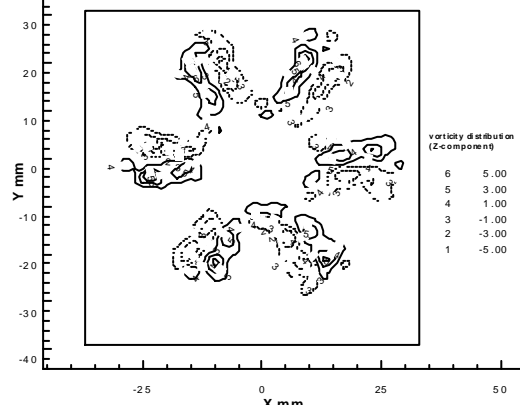
The present dual-plane stereoscopic PIV system was applied to measure an air jet mixing flow exhausted from a lobed nozzle to demonstrate its feasibility. In order to evaluate the measurement accuracy of the present dual-plane stereoscopic PIV system, the measurement results of the present dual-plane stereoscopic PIV system were compared with the simultaneous measurement results of a LDV system. It was found that both the instantaneous data and ensemble-averaged values of the stereoscopic PIV measurement results and the LDV measurement results agree with each other well. For the ensemble-averaged values of the out-of plane velocity component at comparison points, the differences between the stereoscopic PIV and LDV measurement results were found to be less than 2%.

Key words: Stereoscopic PIV technique, Simultaneous measurement of the all three components of velocity and vorticity vectors, The measurement of auto-correlation and cross-correlation coefficients of flow variables, Polarization separation of laser beams, Lobed jet mixing flow.

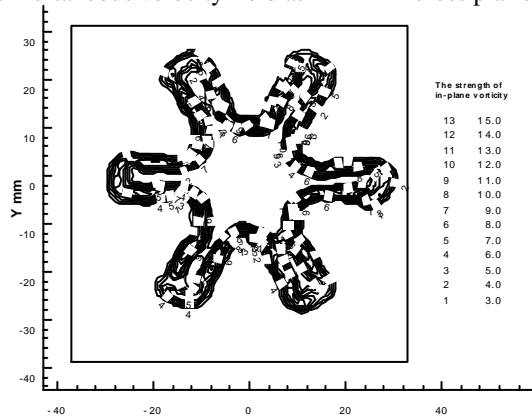


a. Instantaneous result at Z=10mm plane

b. the simultaneous velocity field at Z=12mm cross plane



c. Instantaneous streamwise vorticity field



d. instantaneous in-plane vorticity distribution