3D PIV Car Side Mirror Test

Aerodynamic Flow Analysis Using Tomo-PIV

Particle image velocimetry (PIV) is a powerful optical technique used to visualize and quantify fluid flow. By tracking seeded particles within the airflow, engineers can measure displacement, velocity, and complex flow structures. For advanced volumetric analysis, **Tomographic PIV (Tomo-PIV)** utilizes a multi-camera configuration to provide a complete 3D reconstruction of the flow field. This methodology is vital in the automotive and aerospace industries, where aerodynamic performance is essential for product design and optimization.

Objective

The primary objective of this study was to **validate the aerodynamics** of a specific car side mirror design. By observing the **complex flow patterns** around the mirror, engineers could assess the efficiency and behavior of the **designed model**.

Description of the Case Study

The experiment utilized a scaled-down, **3D-printed model** to manage the power requirements for the illumination system. The technical setup included:

❖ **Illumination:** A 1000 mJ double-cavity pulse laser was used to illuminate the flow field.

❖ **Image Acquisition:** Four 5 MP cameras in a volumetric setup were used to record the flow, enabling a full 3D reconstruction of the velocity field.

❖ **Measurement Volume:** The setup covered a volume of 150 x 115 x 90 mm.

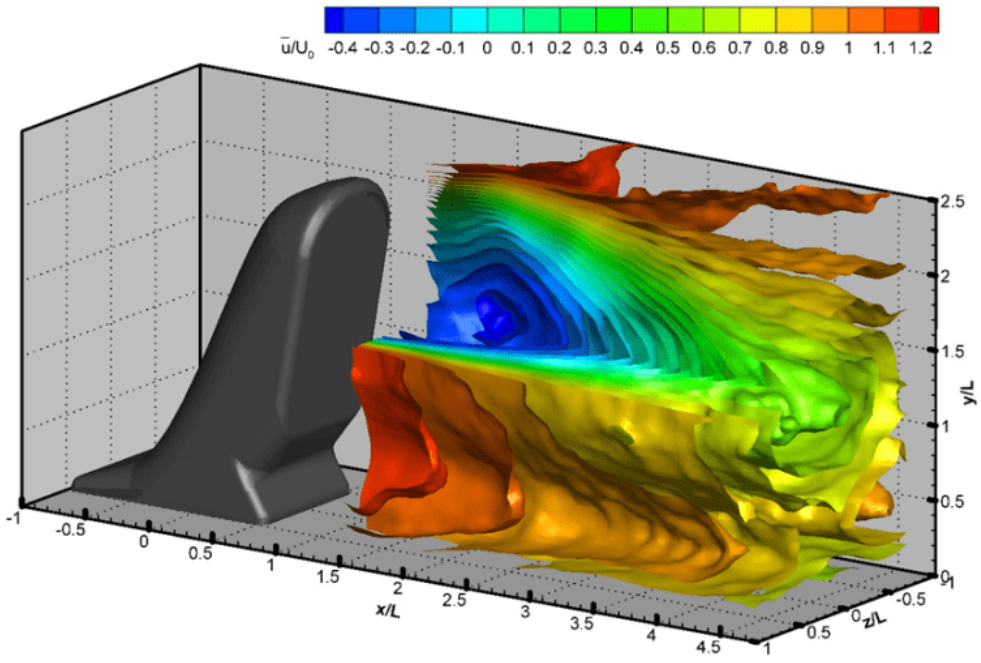
❖ **Resolution and Rate:** The system achieved a 5 Hz acquisition rate, reconstructing 90 x 68 x 52 velocity vectors with a spatial resolution of 3.2 mm.

MicroVec

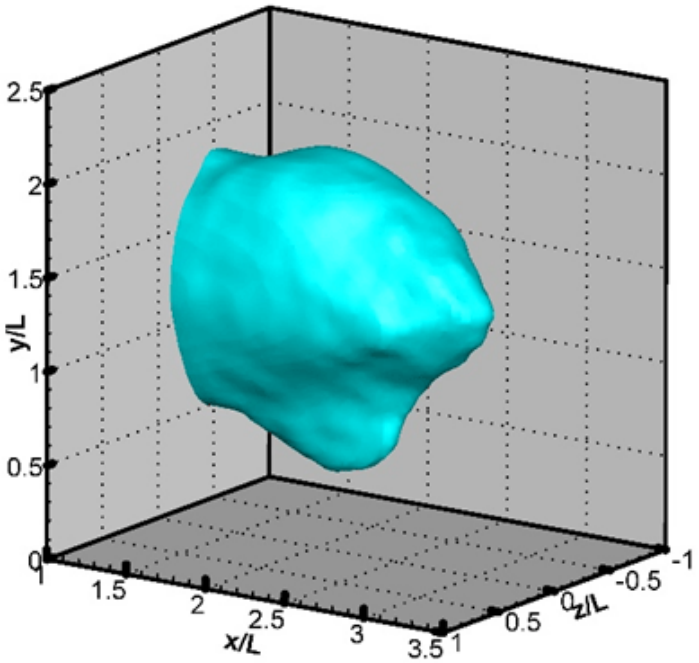
Results obtained with KRYTEN's Stereo PIV software

The **particle image velocimetry** analysis provided high-resolution insights into the flow structures surrounding the side mirror:

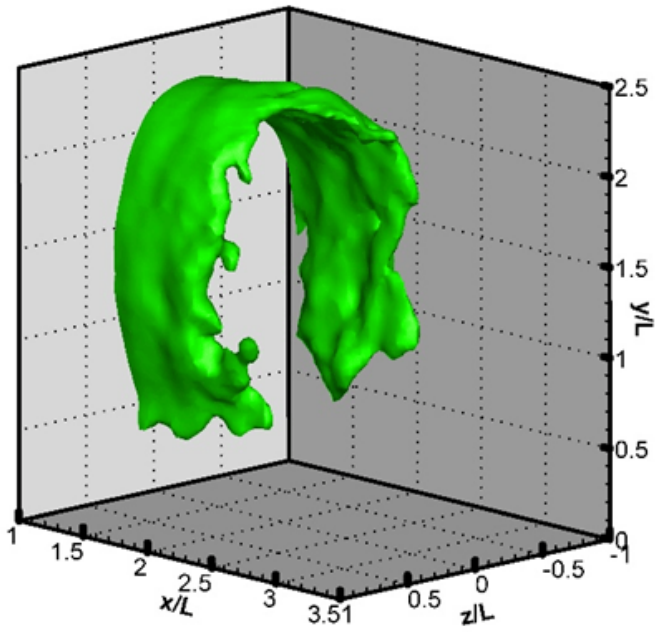
❖ **Velocity Contours:** Generation of an iso-surface of the velocity contour at *Re = 8500*.



❖ **Backflow Identification:** Detection of critical backflow regions where $\bar{u} = 0$.



❖ **Shear Layer Analysis:** Identification of the shear layer with a calculated value of $|\varpi L / U| = 4$



These results contributed to improved understanding of aerodynamic performance and supported **design optimization** of the car side mirror.

Advantages of Using Particle Image Velocimetry

❖ **Full-field flow visualization** – capture complete velocity fields across large areas

❖ **3D flow visualization** – essential for analyzing the complex aerodynamic structures

❖ **Non-intrusive measurement** – provides data without disturbing the flow being analyzed

❖ **Scalable setup** – suitable for both small-scale 3D-printed models and large-scale wind tunnel experiments

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