

# PRESSURE EVALUATION FROM VELOCITY MEASUREMENTS

APPLICATION NOTE PIV-022 (US)

Combined with the velocity field, the pressure field gives a complete description of the flow dynamics. The pressure field in a fluid is the main contributor to the aerodynamic loading of bodies immersed in the fluid so determining it is of great interest in both fluid mechanics and engineering. The benefit of Particle Image Velocimetry (PIV) is that it is a non-intrusive measurement method and it provides a high spatial resolution which is unavailable when using pressure transducers.

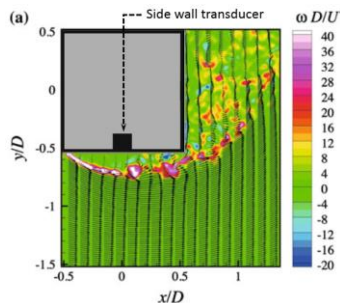
TSI has implemented a method for measuring instantaneously the pressure and velocity fields based on the studies of Kat & Oudheusden, 2012. The operating principle of obtaining pressure from PIV consists in solving the incompressible momentum equation (1) using a Poisson solver with considering a reference pressure and Neumann conditions as boundary conditions in the measurement domain:

$$\nabla p = -\rho \left\{ \frac{\partial u}{\partial t} + (u \cdot \nabla) u - \nu \nabla^2 u \right\} \quad (1)$$

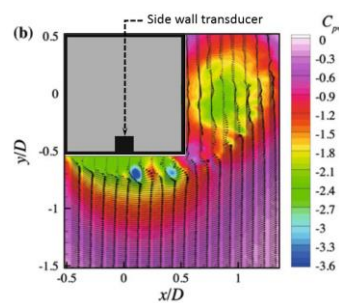
Some rule of thumbs need to be considered to correctly capture the instantaneous pressure from PIV:

- The interrogation window size needs to be at least 5 times smaller with respect to the flow structures.
- The acquisition frequency needs to be 10 times higher than the frequency in the flow.
- In 3D flows, all components of velocity and velocity gradients are needed which may be accomplished by V3V™ technique.

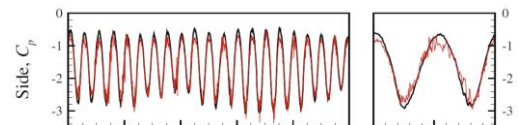
An example of a vorticity/pressure fields measured using SPIV around a square section body is shown in figures (a) and (b) below. The pressure signal derived from velocity shows a good agreement with the signal measured using a pressure transducer (c):



(a) Vorticity field



(b) Pressure field



(c) Pressure signal from stereo-PIV (red) vs Transducers (black)



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## Reference

R. de Kat, B. W. van Oudheusden, Instantaneous planar pressure determination from PIV in turbulent flow, *Exp Fluids* (2012) **52**:1089–1106.

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