

Experimental assessment of Tomographic-PIV accuracy

G.E. Elsinga¹, B.W. van Oudheusden¹, F. Scarano¹¹ Dept. of Aerospace Engineering, Delft University of Technology, The Netherlands, g.e.elsinga@tudelft.nl**Keywords:** 3D-PIV, PIV accuracy

Tomographic-PIV (Elsinga et al. 2005a) is a recently developed technique that records the tracer particle images from several directions simultaneously and uses tomography to reconstruct the particle distribution within the illuminated volume as a 3D light intensity map. From cross-correlation of two 3D intensity maps corresponding to subsequent exposures of the particle images the velocity field is obtained.

The first assessment of the technique (Elsinga et al. 2005b) was only qualitative and questions concerning the accuracy of the tomographic reconstruction and velocity measurement remained to be addressed. Therefore the present study proposes an experimental investigation to quantify reconstruction noise and velocity accuracy in Tomographic-PIV. Hereto measurements of a circular cylinder wake ($Re_D = 2700$) are performed for a range of seeding densities and measurement volume thicknesses. A four CCD-camera system is used to record the particle images (Fig. 1).

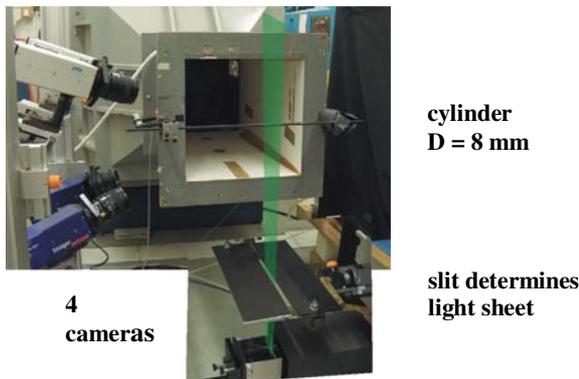


Figure 1: Experimental arrangement in the open-jet low speed wind tunnel

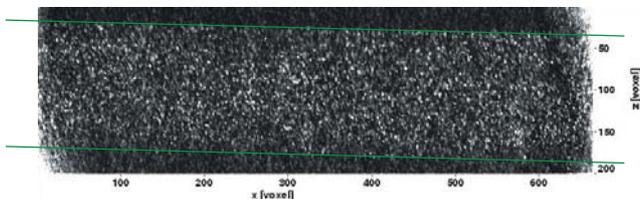


Figure 2: Top view of the reconstructed volume showing the light intensity integrated in y -direction. The green lines indicate the position of the 8 mm thick light sheet (0.03 ppp).

Noisy peaks in the reconstructed 3D intensity map (referred to as ghost particles, Maas et al. 1993) are false triangulations of the recorded particle images, which occur throughout the entire reconstructed volume (Fig. 2), also outside the laser sheet. Therefore the ratio of actual tracer particles N_p and ghost particles N_g can be inferred from a comparison of the reconstructed particles inside and outside the laser sheet. Figure 3 presents N_p/N_g versus the particle

image density in the recorded particle images ppp for a light sheet thickness 4, 8 and 12 mm. A good agreement between measurement and theoretical predictions is observed for $1 < N_p/N_g < 10$, so that the maximum ppp returning accurate reconstructions can be predicted beforehand in future experiments.

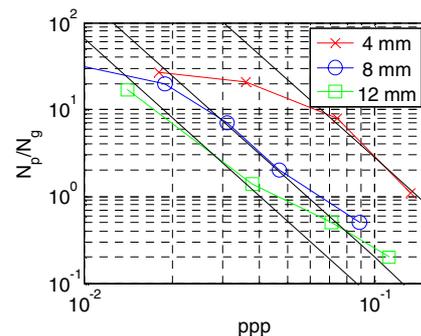


Figure 3: Ratio of actual tracer particle vs ghost particles for varying particle image density and light sheet thickness. Black lines indicate theoretical predictions.

A Stereo-PIV measurement is used to assess the accuracy of Tomographic-PIV. Both the average and RMS velocity distribution (Fig. 4) are compared. Moreover it found that the returned flow statistics do not vary significantly with the particle image density. It is conjectured that ghost particles have only a small contribution to the cross-correlation peak.

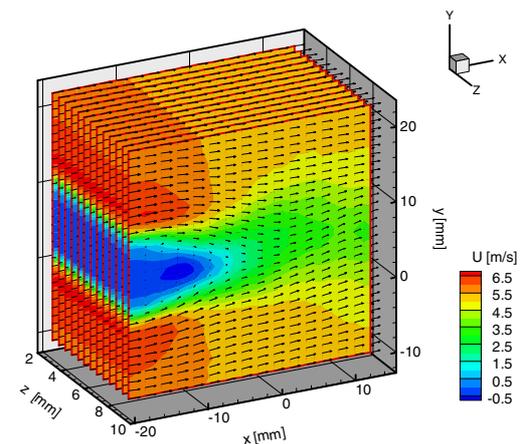


Figure 4: Average velocity over 100 snapshots in an 8 mm thick light sheet for a seeding density of 0.04 ppp .

References

- Elsinga GE, Scarano F, Wieneke B, van Oudheusden BW (2005a) Tomographic particle image velocimetry. *6th Int Symp on Particle Image Velocimetry*, Pasadena, CA, USA
- Elsinga GE, Wieneke B, Scarano F, van Oudheusden BW (2005b) Assessment of Tomo-PIV for three-dimensional flows. *6th Int Symp on Particle Image Velocimetry*, Pasadena, CA, USA
- Maas HG, Gruen A, Papantoniou D (1993) Particle tracking velocimetry in three-dimensional flows. *Exp Fluids* 15: 133-146