Experiments in Fluid Mechanics 2015

Title of presentation:
Shake-the-Box: Lagrangian particle tracking at unprecedented tracer particle density

Authors: Joachim Deppe, Dirk Michaelis
Organisation(s): LaVision GmbH, Germany, Goettingen
Email(s): jdeppe@lavision.de

Abstract:

4D-PTV, as a time-resolved volumetric flow measurement technique, has recently regained a whole new level of attention by the introduction of the award winning* "Shake-the-Box" method [1]. Traditionally PTV has suffered from a poor spatial resolution due to its limitation of measuring flows with a low particle seeding density. Utilizing the temporal information in addition to iterative particle reconstruction [2], now "Shake-the-Box" allows Lagrangian particle tracking at **unprecedented tracer particle density and positional accuracy** [1]. It is applicable at seeding densities as high as - *or even higher than* - the most sophisticated volumetric flow measurement systems so far (e.g. Tomographic PIV).

Extracting individual Lagrangian particle tracks at high seeding densities is offering **unique advantages** compared to traditional measurements on an Eulerian measurement grid:

- The spatial resolution for average fields and Reynolds stresses is not limited to the PIV grid resolution anymore. Using a large number of snapshots, the **spatial resolution can be increased** to the pixel level or even below [3].
- Time-resolved tracking allows more **precise velocity and acceleration** estimation (see Fig. 1 below).
- Precise knowledge of the material derivative enables **reliable pressure** estimation.

Computation time is reduced dramatically, moving from the time and space consuming voxel representation of Tomographic PIV to individual particle tracks. Typically the computation time is **10 to 100 times less** than for Tomographic PIV.

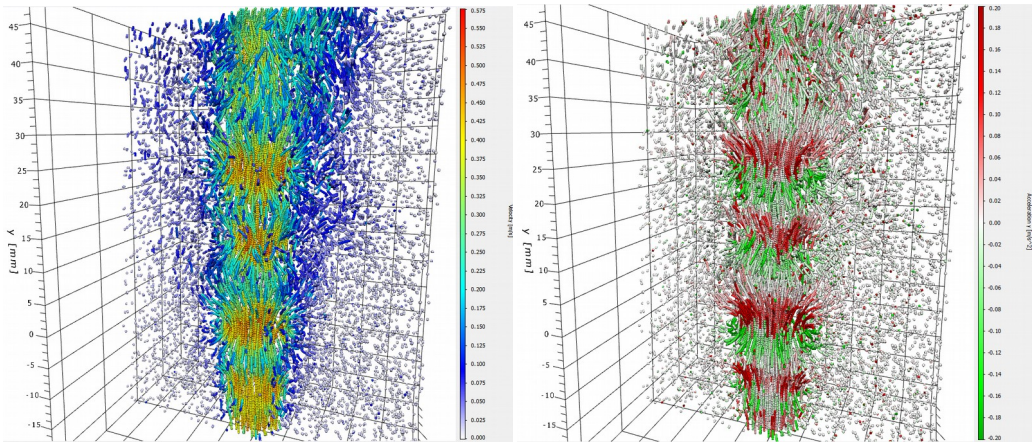

Figure 1. Shake-the-Box results for a free jet in water**: **velocity** (left) and **acceleration** (right). Recorded, calculated and displayed in LaVision's ***DaVis*** software

[1] Schanz et al., 'Shake The Box': A highly efficient and accurate Tomographic Particle Tracking Velocimetry (TOMO-PTV) method using prediction of particle positions, PIV 2013
[2] Wieneke, Iterative reconstruction of volumetric particle distribution, MST 2012
[3] Kähler et al., On the resolution limit of digital particle image velocimetry, ExpFluids 2012

* PIV Challenge 2014 award: D. Schanz with “Shake the Box”
** recordings courtesy D. Violato, TU Delft