

Shake-the-Box

Lagrangian particle tracking
at unprecedented tracer
particle density

Advantages

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 a 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 [4].

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.

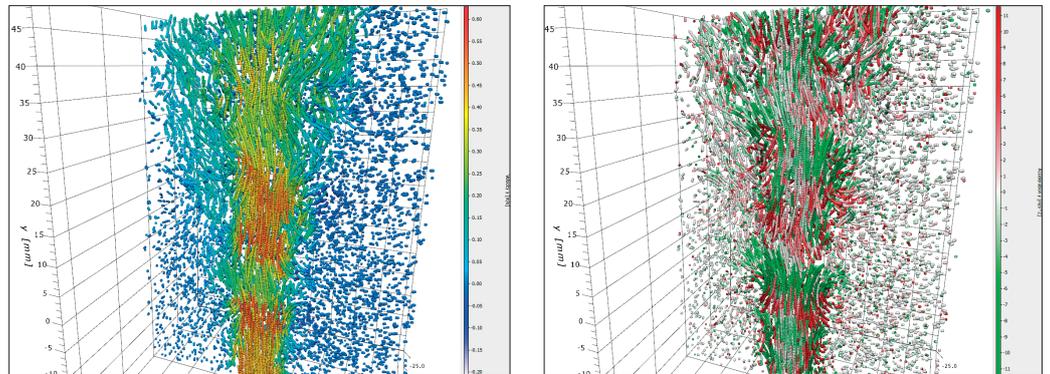


Figure 1: Shake-the-Box results for a free jet in water**. **Velocity** (left) and **acceleration** (right). Recorded, calculated and displayed in LaVision's **DaVis** software

References:

- [1] Schanz et al., Shake-The-Box: Lagrangian particle tracking at high particle image densities, ExpFluids 2016
- [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
- [4] Blinde et al., Comparative assessment of PIV-based pressure evaluation techniques applied to a transonic base flow, 18th ISALTFM, Lisbon 2016

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Jun-16

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

LaVisionUK Ltd

2 Minton Place / Victoria Road
Bicester, Oxon / OX26 6QB / United Kingdom
E-Mail: sales@lavision.com / www.lavisionuk.com
Phone: +44-(0)-870-997-6532 / Fax: +44-(0)-870-762-6252

LaVision GmbH

Anna-Vandenhoeck-Ring 19
D-37081 Göttingen / Germany
E-Mail: info@lavision.com / www.lavision.com
Tel. +49-(0)551-9004-0 / Fax +49-(0)551-9004-100

LaVision Inc.

211 W. Michigan Ave. / Suite 100
Ypsilanti, MI 48197 / USA
E-mail: sales@lavisioninc.com / www.lavisioninc.com
Phone: (734) 485 - 0913 / Fax: (240) 465 - 4306