LaVision

FOCUS ON IMAGING

Courtesy: J. R. Underwood, J. A. Cheney, J. Song and J. Bomphrey, The Royal Veterinary College, UK
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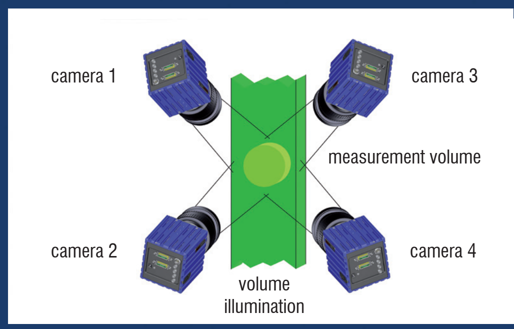
Shake-the-Box

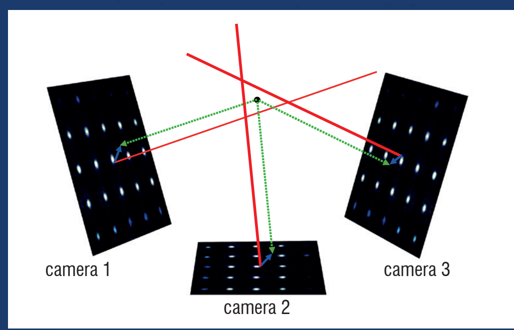
Shake-the-Box describes an evaluation method for densely seeded 3D Particle Tracking Velocimetry/ Lagrangian Particle Tracking experiments developed by the German Aerospace Center (DLR) in Göttingen and LaVision. By iteratively comparing the reconstructed particle scenery with the recorded images and optimizing the particle positions by „shaking“ them into place, a nearly ghost free reconstruction of the three-dimensional velocity field can be achieved.

Courtesy: C. C. Wolf, C. Schwarz, K. Kaufmann, A. D. Gardner, J. Bosbach, D. Schanz, A. Schröder, German Aerospace Center DLR Göttingen



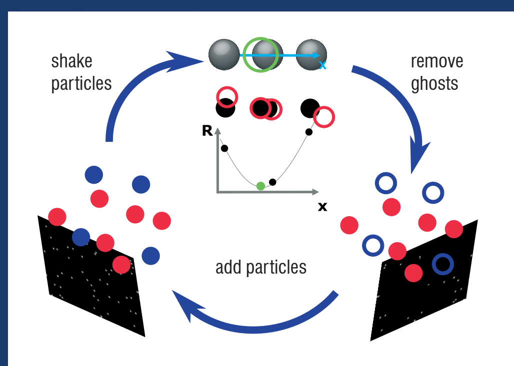
Setup

A multi-camera setup is used to record images of a seeded flow with the aim of reconstructing three-dimensional particle trajectories. Tracer particles can be as small as 1 µm (DEHS) or as large as 300 µm (Helium-filled soap bubbles HFSB), when strong signals are required. Volumetric illumination is either achieved by a laser equipped with a beam expanding optics or by any array of light-emitting diodes (LED).



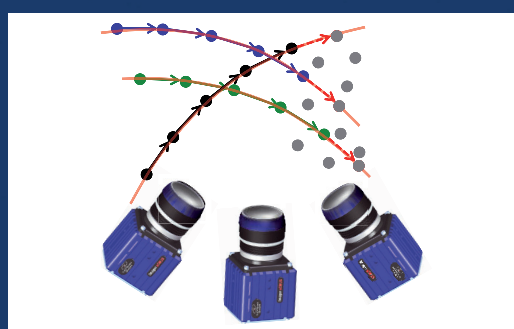
Volume Self-Calibration

After an initial calibration of the camera system with a calibration target, the calibration is refined using a technique called Volume Self-Calibration (VSC). During VSC, the calibration parameters are optimized using the recorded particle images. This can reduce the backprojection errors below 0.1 px, which is crucial for a succesful STB evaluation. As an additional result the Optical Transfer Function (OTF) is determined, which characterizes the shapes and intensities of the tracer particles within the measurement volume.



Iterative Particle Reconstruction

The imaged particles are reconstructed in the three-dimensional space using the Iterative Particle Reconstruction (IPR) method. IPR iteratively adds new particles, optimizes the particle positions by minimizing their backprojected residuals and removes ambiguous ghost particles. This approach yields very good reconstruction results, even at high seeding densities.



Tracking

After the first trajectories have been initialized, the particle positions within the subsequent recordings are predicted and optimized by shaking the particles into place. The extrapolation of already established trajectories reduces the computational costs of the reconstruction problem significantly and minimizes ambiguities, when new particles are added. After just a few time steps, STB converges and a nearly ghost free reconstruction of the velocity field is achieved. STB is also capable to work with double-pulse and multi-pulse recordings.

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