LaVision
FOCUS ON IMAGING

In Application

Instantaneous Volumetric 3D3C Flow Imaging

FlowMaster Tomographic PIV

Introduction

LaVision's **FlowMaster Tomographic PIV** system is based on the illumination, recording and reconstruction of tracer particles within a **three-dimensional measurement volume**. This technique makes use of several simultaneous views of the illuminated particles and the three-dimensional light intensity reconstruction is **based on optical tomography**. The analysis of the light intensity distribution in the 3D volume is performed with the **MART reconstruction algorithm**, yielding a 3D array of light intensity discretized over voxels (volume elements). The reconstructed volume pair is then analyzed by means of **FFT-based 3D cross-correlation**. As a result, a 3D flow field is obtained presenting 3C velocity information for each voxel element.

In contrast to other volumetric measurement techniques like 3D-PTV **10 times higher seeded** flow phenomena can be measured resulting in a **10 times higher spatial resolution** by using the same experimental setup. The volume depth is only limited by depth-of-field and laser power, so even measurements of **cubic volumes** are possible, e.g. in water with larger seeding particles. Typically measurements with 1k x 1k cameras yields more than **50 000 - 100 000 vectors** compared to the 3D-PTV technique with e.g. 1000 - 5000 vectors. With 2k x 2k cameras even **up to 400 000 vectors** can be obtained.

The range of application for the Tomographic PIV technique can be extended to **4D time-resolved volume-PIV measurements** with high-speed cameras.

When applied to **thin volumes**, Tomographic PIV achieves the same **high in-plane spatial resolution** and accuracy as Stereo-PIV, while at the same time providing the full 3x3 velocity gradient tensor or even information about small scale 3D structures within 3 - 10 vector planes.

LaVision's Tomopgraphic PIV system is applicable **to air and water flows** and is based on LaVision's well known DaVis PIV software, which has been rated consistently among the **best PIV-software** in all 3 PIV-Challenges. DaVis provides a **high level of integration** of cameras and hardware including laser, ADC, energy monitor, image intensifier, translation stages, etc.

Tomographic PIV requires calibration accuracies of a fraction of a pixel throughout the complete volume, which is difficult to achieve experimentally. Therefore a **new volumetric self-calibration technique** has been developed based on the computation of the 3D-position of matching particles by triangulation which is also implemented in LaVision's DaVis software.

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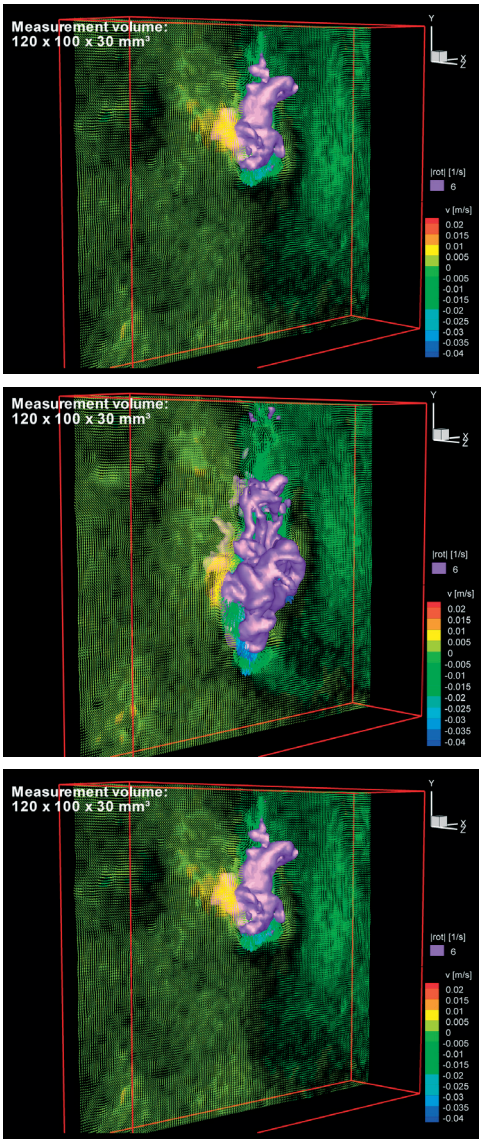
System Features

- full 3D3C velocity fields
- time resolution with high-speed cameras
- integrated turnkey laser imaging system for instantaneous volumetric 3D3C measurements of flows in air and in water
- complete hardware control using DaVis
- Volume Self-calibration:
  intelligent, patented calibration technique based on computation of triangulation of matching particles
- easy and flexible setup options with no limits to any kind of experimental conditions
- straight forward upgrade path from 2D or 3D stereoscopic PIV systems

Specials and Upgrades

- Thick sheet Tomographic PIV:
  alternative to dual-plane Stereo-PIV for computing instantaneous 3x3-gradient tensors with an easier calibration and a higher accuracy
- Time-resolved Tomographic PIV:
  measurement of 4D instantaneous velocity vector volumes, e.g. for investigation of coherent vortical (sub-)structures in flows.

Application Example



The FlowMaster Tomographic PIV sytem is applied to a volume of 120 x 100 x 30 mm^3 in water illuminating a jet injected by a syringe with a 1 Watt cw-laser. Images of the glass hollow spheres seeded water in the tank are recorded with 4 x Imager *pro* X 4M cameras.

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