

## Pressure from PIV

Instantaneous & averaged  
pressure fields  
from velocity data

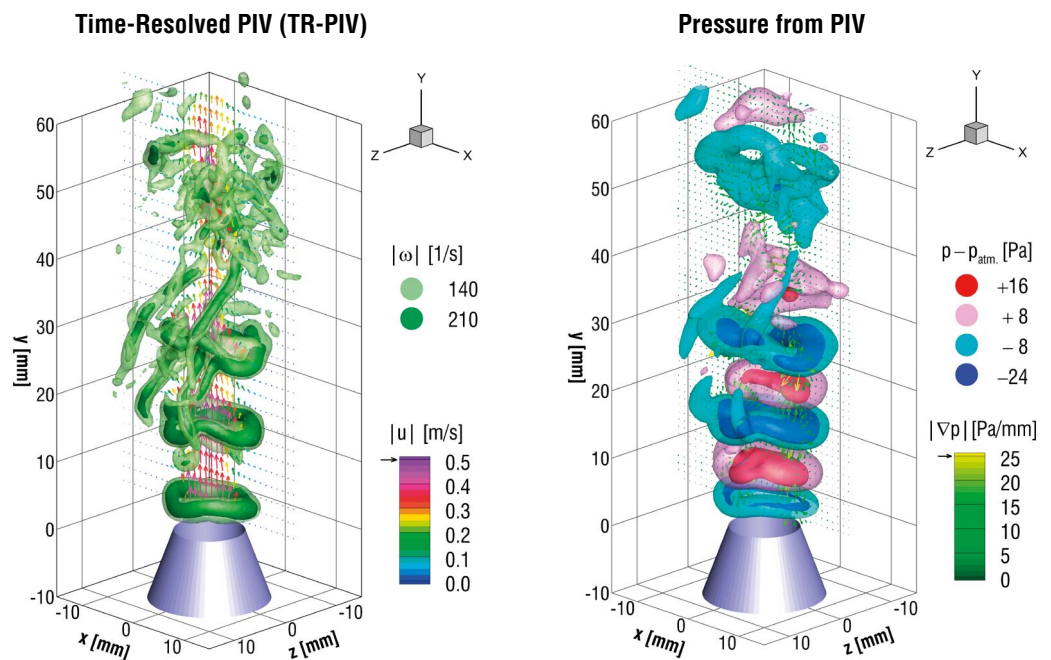
Example: Pressure computed  
for time-resolved jet flow

Pressure measurements are extremely valuable for greater insights in main research areas like turbulence research and others. Pressure is also fundamental for the understanding of Fluid-Structure Interactions.

Commonly, pressure measurements are retrieved pointwise, for instance with pressure taps or Pitot tubes, making full 3D pressure field measurements very tedious. Instrumentation of wind tunnel models with pressure sensors is time consuming, complex and expensive.

These obstacles have triggered a high demand in the fluid dynamics community for direct, non-intrusive pressure retrieval. Groups from several universities and LaVision joined forces in the European **NIOPLEX**<sup>1</sup> project, that finally pinpointed practical ways for pressure calculation from PIV/PTV measurements:  
**Pressure from PIV.**

Pressure computation is now possible with the new software package **Pressure from PIV** in LaVision's latest **DaVis** software. Only a few clicks in **DaVis** give access to 2D and 3D instantaneous or time-averaged pressure fields directly retrieved from **2D-PIV, Stereo-PIV, Tomographic-PIV or Shake-the-Box (4D-PTV)**, recordings.



*Instantaneous iso-surfaces of vorticity (left) and pressure (right) for a free jet in water evaluated with DaVis 10 (recordings with courtesy of D. Violato, TU Delft)*

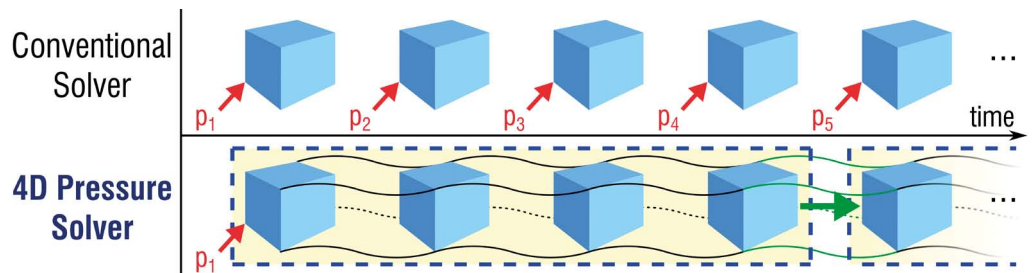
New 4D Pressure Solver

Further inhouse developments lead to improved **Pressure from PIV** algorithms: Sophisticated mathematics, including a new **4D Pressure Solver**<sup>2</sup> for instantaneous pressure fields, now yields stable and reliable pressure results.

<sup>1</sup>NIOPLEX "Non-intrusive Optical Pressure and Loads Extraction for Aerodynamic Analysis" <http://nioplex.eu>

<sup>2</sup>ISPIV 2017: "Boundary condition assignment for evaluating instantaneous pressure field from Time-resolved PIV" by Young Jin Jeon, Markus Müller, Dirk Michaelis, Karsten Pfeiffer, and Bernhard Wieneke, Session M1 on Monday 19th at 11:15

The **4D Pressure Solver** takes 4D spatio-temporal blocks into account. Each 4D block consists of multiple 3D domains and their Lagrangian connections in the time domain. User-defined boundary conditions are only required for the first time step of the first 4D block. For the following 4D blocks, pressure results from previous blocks are transferred to the next 4D step.



### Advantages

There are several unique and important advantages of the new 4D approach:

- ▶ It only takes minimum effort to define boundary conditions.
- ▶ Temporal continuity of pressure is inherently enforced by the new algorithm. This reliably prevents unphysical fluctuation in the computed pressure fields, often visible for less sophisticated single-time-step methods.
- ▶ Most of today's pressure solvers rely on a rectangular measurement domain. For irregular domains, pressure can only be calculated in a much smaller confined rectangular sub-region. But especially in PIV measurements, the measurement domain often displays an irregular shape resulting from illumination limitations or image masking (e.g. due to reflections or obstacles in the flow). In contrast, with LaVision's new **4D Pressure Solver** there are no limitations on the shape of the test domain - the shape of the domain may even change in time. The latter feature is particularly fundamental for Fluid-Structure Interaction research where time-variable flow boundaries inside the measurement domain are very common.
- ▶ The new **Pressure from PIV** module is compatible with all kinds of PIV and PTV velocity data either imported or directly retrieved by **DaVis** software.

### Applications

Instantaneous or average pressure computations are possible depending on the PIV system in use:

| LaVision's Systems            | Average pressure | Instantaneous pressure |
|-------------------------------|------------------|------------------------|
| 2D-PIV                        | ✓                |                        |
| Stereo-PIV                    | ✓                |                        |
| Tomographic-PIV               | ✓                |                        |
| Time-resolved 2D-PIV          | ✓                | ✓                      |
| Time-resolved Stereo-PIV      | ✓                | ✓                      |
| Time-resolved Tomographic-PIV | ✓                | ✓                      |
| Shake-the-Box (4D-PTV)        | ✓                | ✓                      |

Data provided by LaVision are believed to be true. However, no responsibility is assumed for possible inaccuracies or omissions. All data are subject to change without notice.

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Please contact LaVision if you are interested in applying our new **Pressure from PIV** solution.

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