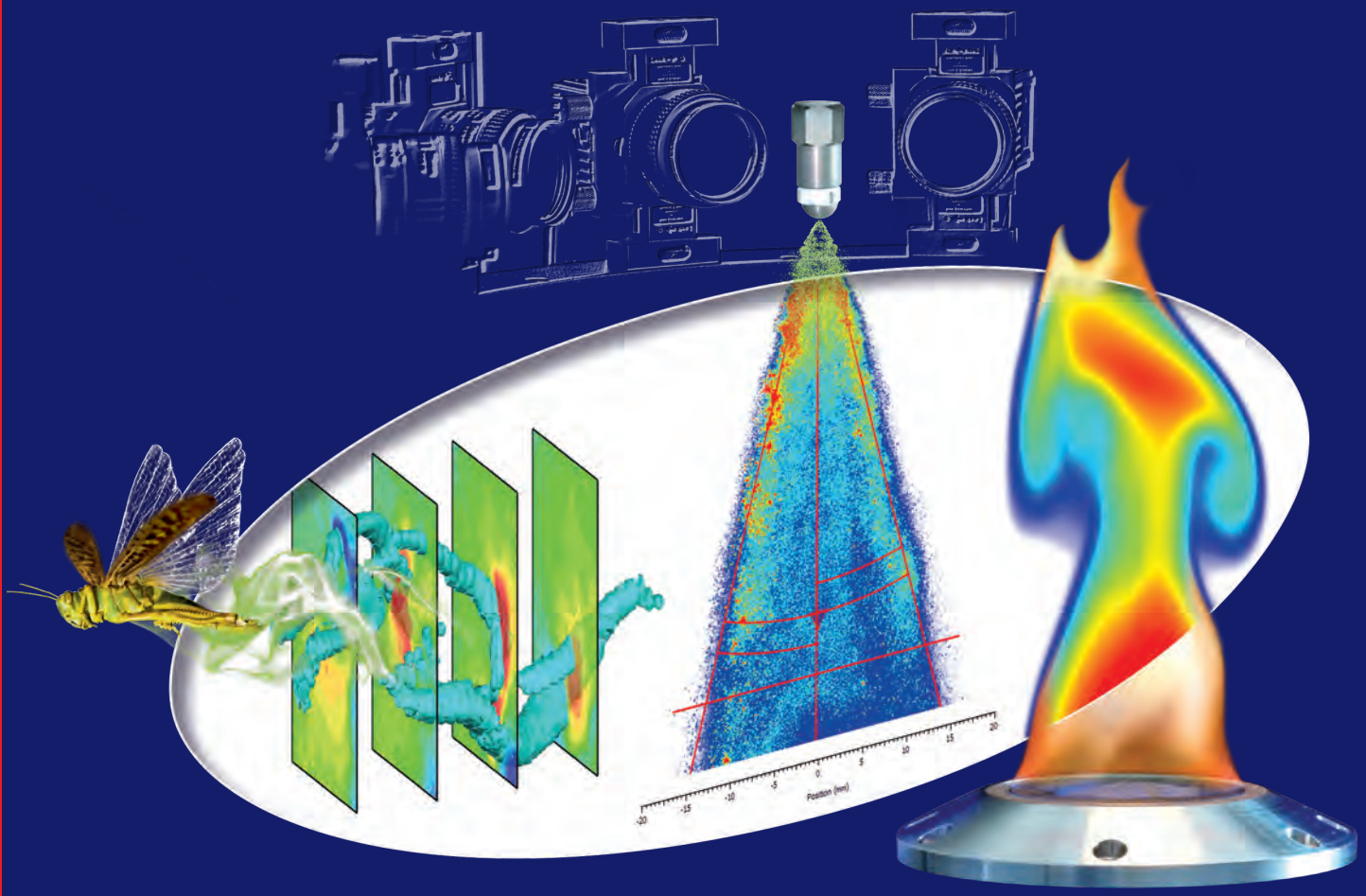


DaVis

Software for Intelligent Imaging

LaVision

FOCUS ON IMAGING

All LaVision's intelligent imaging systems are driven by **DaVis**, our powerful and comprehensive software for data acquisition, visualization and processing.

Why DaVis?

- comprehensive software solution for multi-dimensional, multi-parameter (laser) imaging
- ultimate system integration built on fully software embedded device control
- leading edge image processing algorithms
- **DaVis** is extensively field proven and continuously enhanced by our experienced team of engineers and scientists
- based on more than 25 years of leadership in multi-parameter imaging

Features and Benefits

- leading edge algorithms for highest result quality
- very flexible and versatile data acquisition with fully integrated camera and device control
- mixed-model multi-camera and multi-laser support
- advanced synchronization schemes to external events
- native 64 bit operating system application for huge and fast image memory
- 2D and 3D visualization of data, especially for vector fields, its derivatives and raw images
- statistics on image data, vector fields, vector derivatives, and PIV uncertainty
- processing speedup by use of multi-core CPUs and GPUs
- large extensible library of built-in processing and filtering functions
- data import and export from and to several image, movie and numerical formats
- data management in application specific projects
- free plugins for MATLAB® and Tecplot®
- free lifetime support and upgrades within a major release over many years

Application Modules

DaVis offers a wide range of application specific modules for **Fluid Mechanics**:

- full 4D resolved flow fields from Stereo-PIV, time-resolved PIV, Tomographic PIV

Material Science:

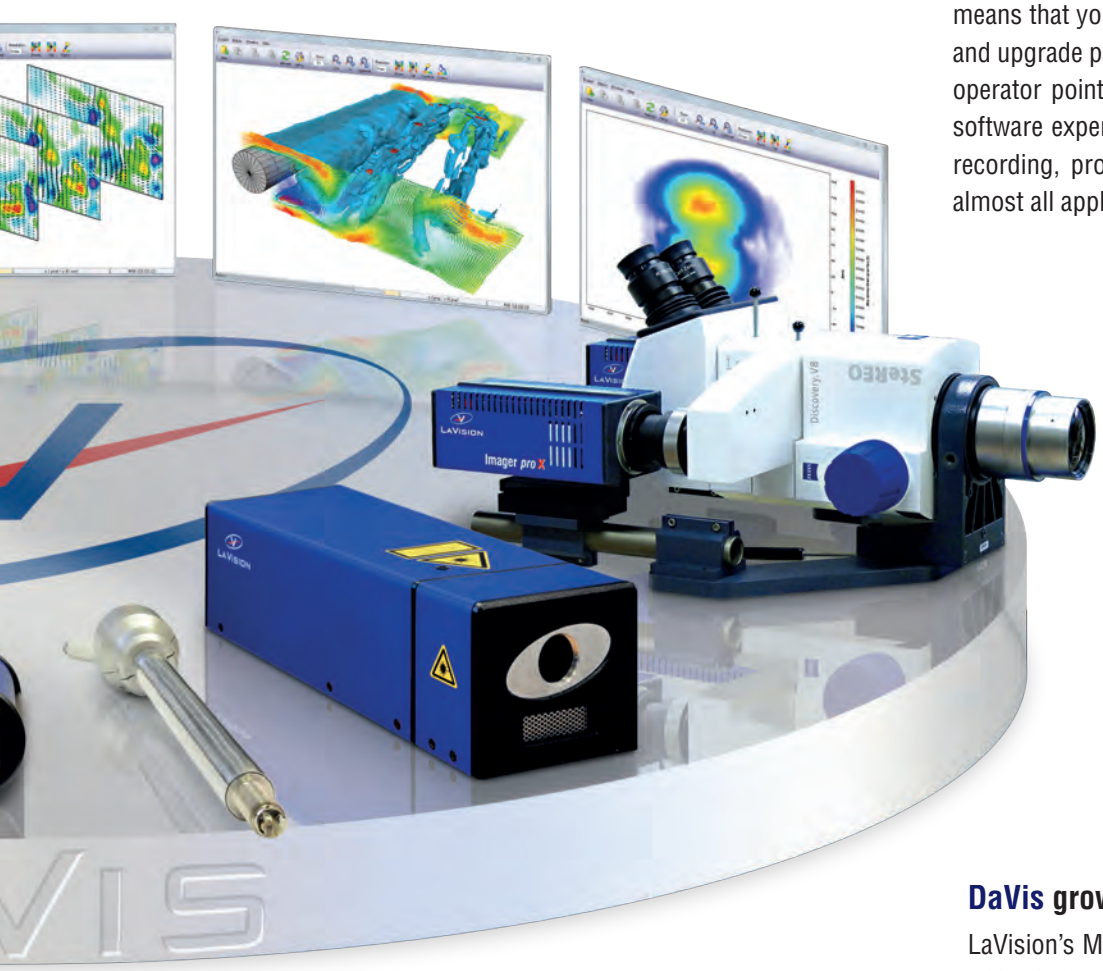
- surface deformation, strain, surface shape from DIC, Fluid-Structure Interaction, volume deformation from DVC

Sprays:

- plume geometry, spray pattern, density, planar D_{32}, liquid-vapor separation, droplet size

Combustion & Mixing:

- temperature, mixture fraction, flame propagation, flame radicals, soot and other emissions, pH-value



Modularity

Modularity in **DaVis** is achieved by the combination of the **DaVis** platform with application specific modules. This means that you only invest in functionality that you need, and upgrade paths are open to future extensions. From an operator point of view this concept provides a common software experience for all packages. Basic activities like recording, processing and exporting data are similar in almost all application specific packages.

Integration

DaVis as the foundation integrates all software and hardware components in a single platform. All hardware is fully integrated to achieve maximum performance and best user experience.
The integration concept of **DaVis** allows the combination of various hardware components, such as different camera models within the same measurement system.

Fully Integrated Hardware

DaVis supports a large number of hardware components, all fully integrated and controlled by the software.

Cameras and Lasers:

- high performance CCD, sCMOS and CMOS cameras
- high-speed cameras
- lasers, flash lamps, LED lighting

Optics:

- remote lens and Scheimpflug optics
- microscopes, MITAS devices
- polarization controllers, shutters

Actuators and Sensors:

- translation and rotary motion controllers
- rotary and crank angle encoders
- laser energy monitors, A/D-converters

DaVis grows with your needs

LaVision's Multi-Parameter Imaging concept provides a wide choice of applications based on modular and compatible software and hardware components.
Making use of this concept, a **DaVis** based system can grow with your needs following several open upgrade paths.

Open upgrade paths

It is our philosophy to keep our systems open for future upgrades. You start with exactly the functionality you need. As your project or test program progresses, your requirements may change, such as going into the 3rd dimension or the need for additional types of data, we provide upgrades necessary for hardware and software.
DaVis is open to upgrade to either more detailed functionality (like a Stereo-PIV to a tomographiv PIV system) or in a wider spectrum of measured properties, like temperature in addition to a flow field.

Integrating all tasks in a DaVis project

You can do many tasks with **DaVis**: record images with up to 8 fully synchronized cameras simultaneously. Process image data to obtain a flow field, temperature map, or particle statistics. Export results for further evaluation or presentation. Make use of built-in wizards to accomplish optimum results.
This all runs from the same **DaVis** software. There is no need to switch between different programs for different tasks. Each specific application is associated with a unique **DaVis** project type and this makes you focus on the features you need.

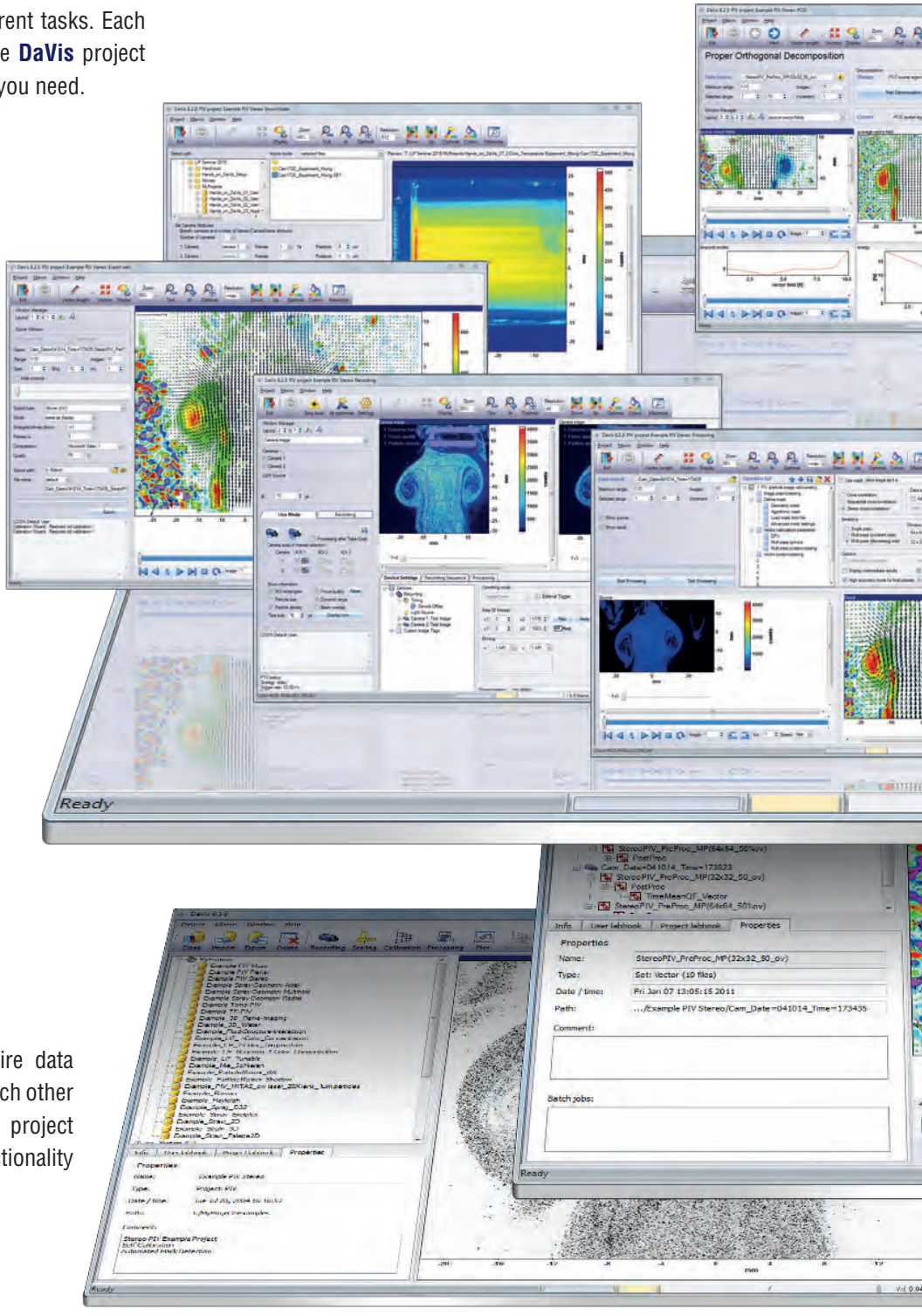
DaVis Dialog Concept

The main concept of the **DaVis** user interface consist of 3 levels

- **Level 1: the project browser**
- **Level 2: project data viewer**
- **Level 3: task specific dialogs**

The project - the homepage for your data

The **DaVis** dialog concept helps you to always find your way back to the central data viewer: the project page. Even from the deepest detailed dialog you will easily find your way back to this central page, like the homepage of a website.

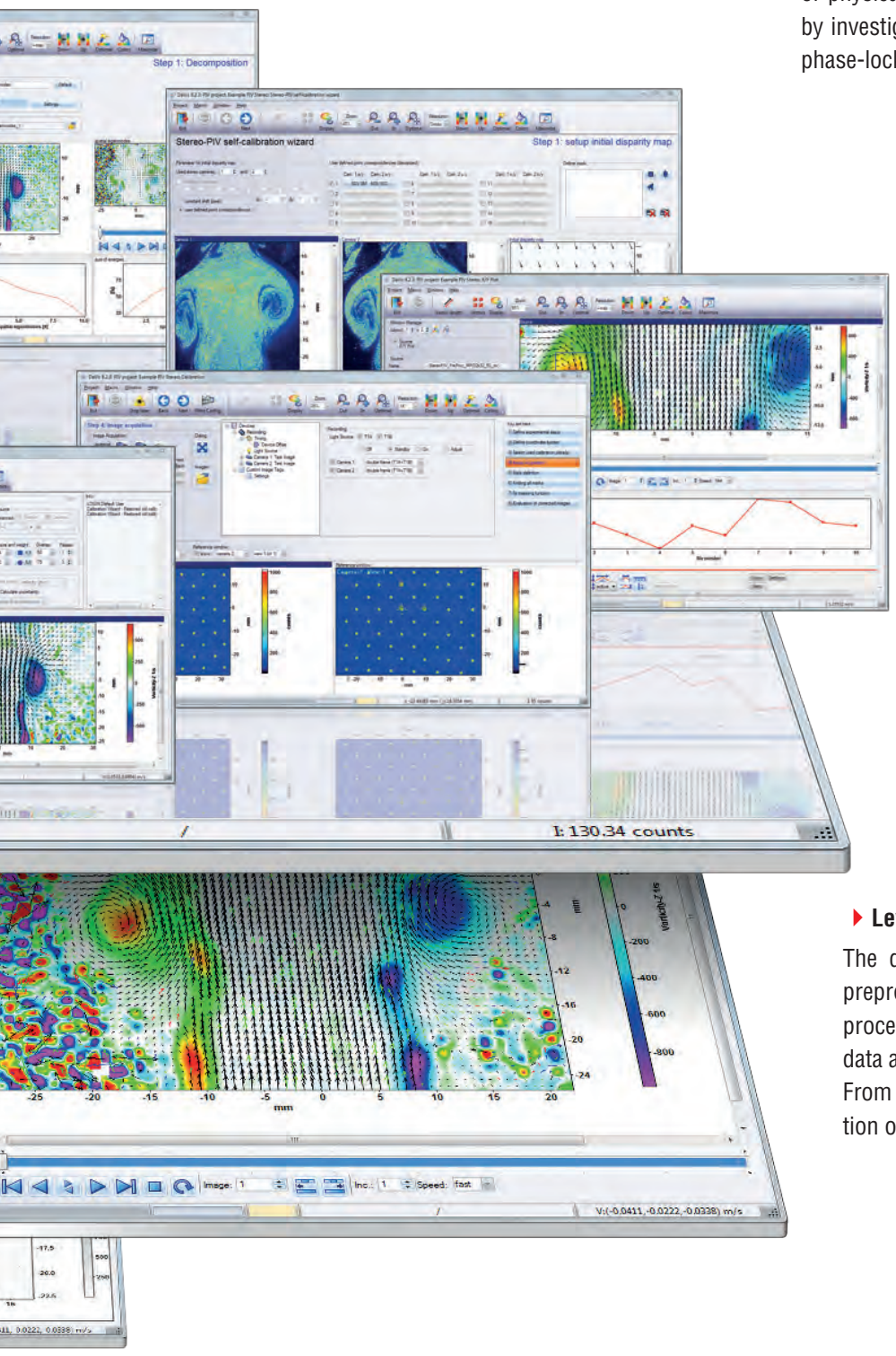


Level 1: the project browser

The project browser shows your entire data collection. Data in a project belong to each other and have a common calibration. Each project makes **DaVis** display exactly the functionality which you need for your tasks.

Data viewer – presenting multiple dimensions

The project data viewer is a central part in **DaVis** for browsing, viewing and managing your data. With the multi-parameter imaging systems from LaVision you will easily create multi-dimensional data. Starting with the 2 dimensions each camera has, **DaVis** adds the 3rd dimension by tomographic reconstruction or physical scanning. Time as the 4th dimension will be added by investigation of transient phenomena with time-resolved or phase-locked recordings.



Level 3: task specific dialogs

For each task, **DaVis** presents a full screen specialized dialog to find all necessary tools under your mouse pointer. From each dialog you easily find your way back to the data browser. This streamlined dialog hierarchy assists you to perform all necessary tasks within a clear structure

Level 2: project data viewer

The data viewer presents recorded camera images, preprocessing steps, processing results, and all post processing steps. It helps you navigating through your data and manages the calibration files.
From the data viewer you can directly jump to a selection of specific functions.

Processing with DaVis

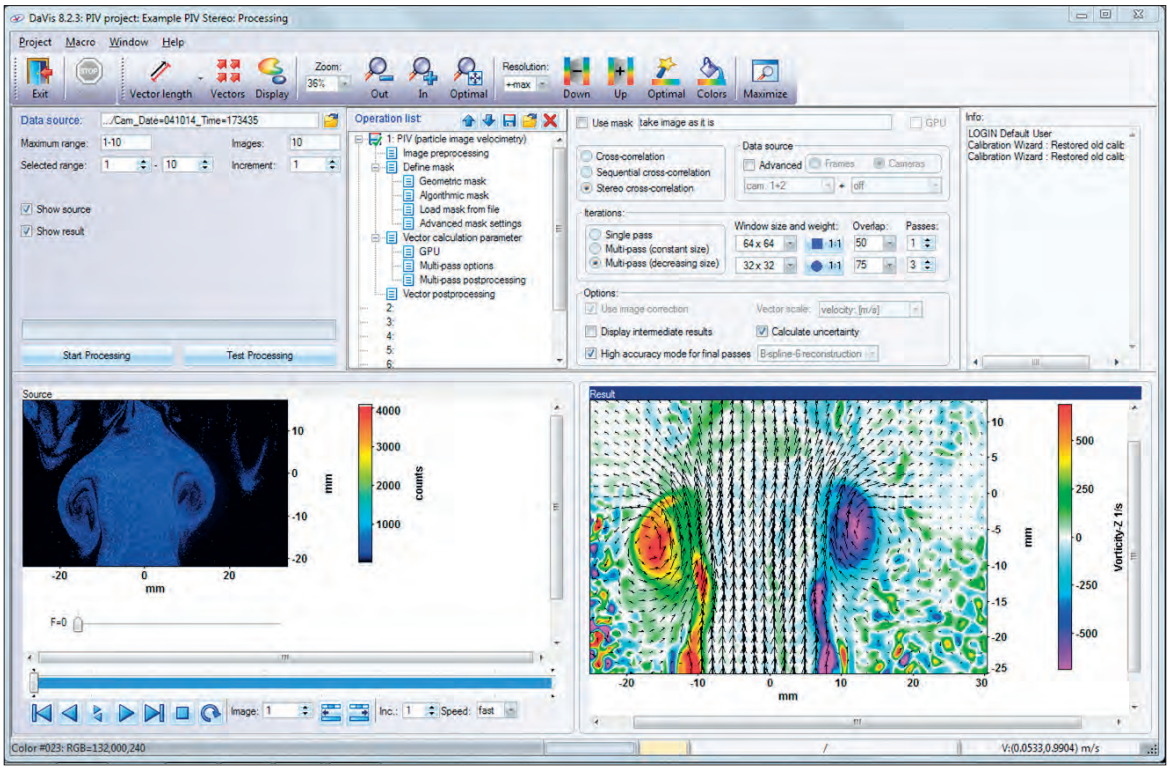
Processing is the core functionality of **DaVis**: doing the computational work on recorded images. Data from LaVision‘s imaging systems are normally arranged in sets with tens or hundreds of camera image files. Image data from a camera are unprocessed and contain grey-scale (or color coded) 2-dimensional light intensity information. The “processing” removes image artefacts (like background and laser intensity gradients), applies filters (like smoothing, noise reduction, thresholding) and converts them to the desired physical property, or into a 3-dimensional representation. This could be velocity maps, concentration and temperature fields, or a list of analyzed particles.

Parallel processing - full usage of all CPU kernels

DaVis processing makes optimum use of multi-core systems. Computationally intensive algorithms like Stereo-PIV are fully parallelized even for a single image. For all other functions **DaVis** automatically applies parallel processing over multiple image files. This makes best possible use of the processing power of a typical multicore CPU computer.

Distributed processing

Time consuming operations like PIV can be spread over a Linux cluster. The **DaVis** setup allows you to install a remote worker version of **DaVis**.

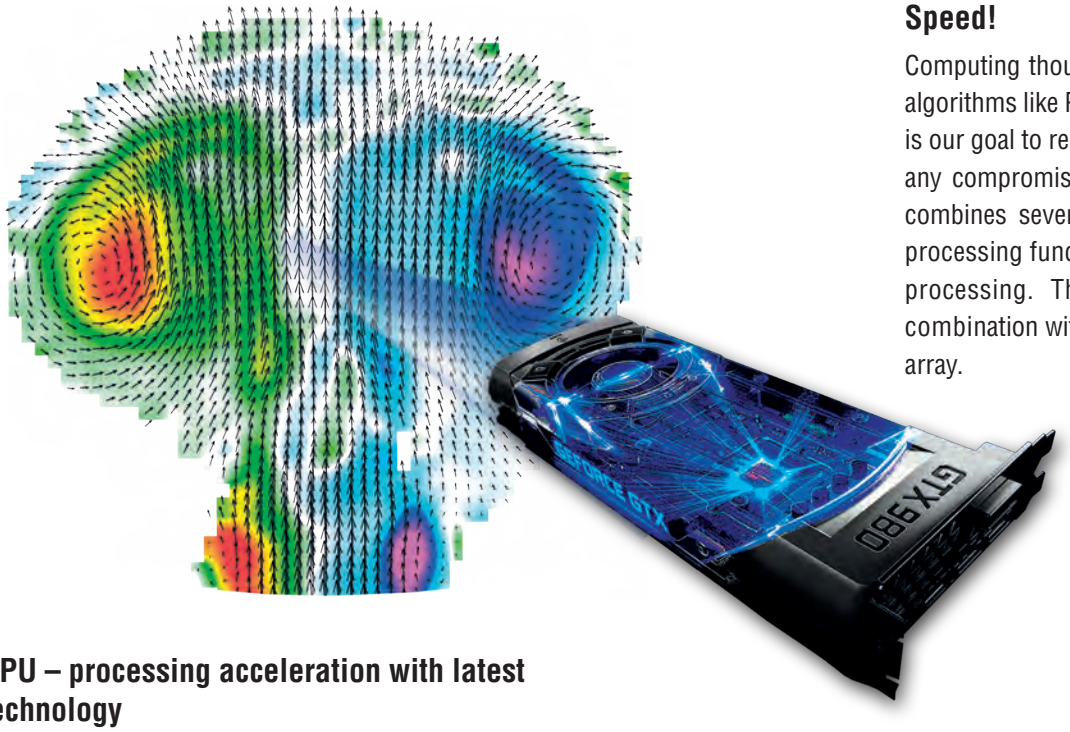


Processing pipeline

You can create your individual processing chain by stacking several elementary processing functions together. The result of the preceding function will be fed into the next function in the list. You can directly follow the result of each intermediate step of the processing pipeline.
The processing list automatically checks consistency of data type and functions (e.g. vector data for vector processings) and allows you to temporarily disable single functions without destroying the current processing chain. Once you are satisfied with the result, the entire processing chain can be stored for later retrieval under a unique name.

Traceability - processing history

Traceability is very important in any field of research, and essential for quality control. **DaVis** allows you to recall all processing functions used on previously processed data.
When applying any type of processing, even when you write your own processing functions, all information on the processing chain and the settings used will be stored together with the result file. **DaVis** recovers these settings by a mouse-click.



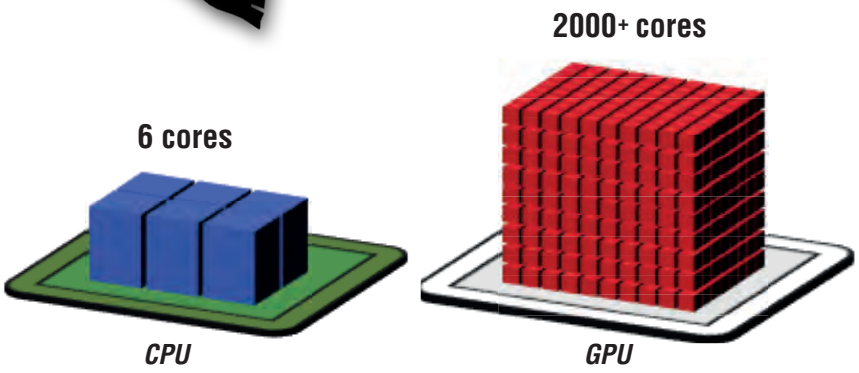
Speed!

Computing thousands of raw images with sophisticated algorithms like PIV takes your valuable time. Therefore, it is our goal to reduce the computing time without making any compromise in result quality and precision. **DaVis** combines several techniques to accelerate the built-in processing functions, like using **GPU** cards and parallel processing. The best performance is achieved in combination with a fast storage system, like a RAID disk array.

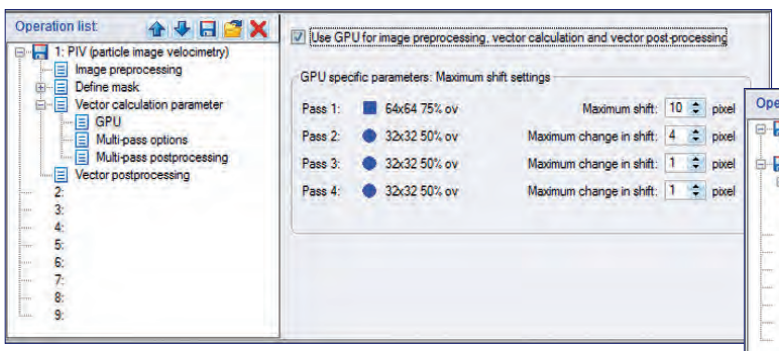
GPU – processing acceleration with latest technology

GPUs (Graphics Processing Units) are originally designed to accelerate computer graphics rendering, e.g. for computer games. Time consuming processings like Stereo- and Tomographic PIV will produce results about 10 times faster when running **DaVis** 8 enabled with the **GPU** module and a **GPU** in your PC.

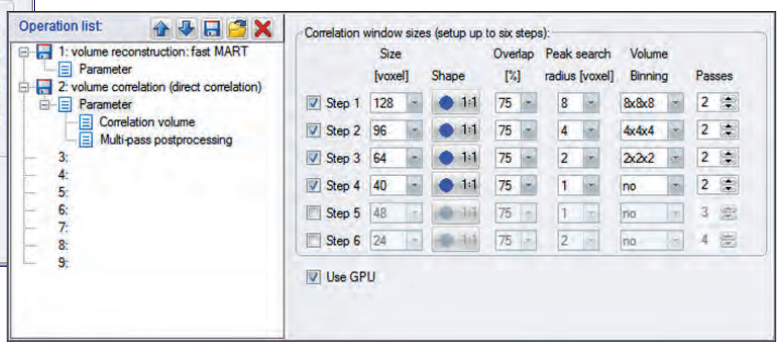
DaVis 8 contains **GPU** optimized PIV code and makes use of several thousands of speed optimized parallel processing units on modern **GPU** cards. Multiple **GPU** cards in the same PC can give even more processing power for a very moderate investment.



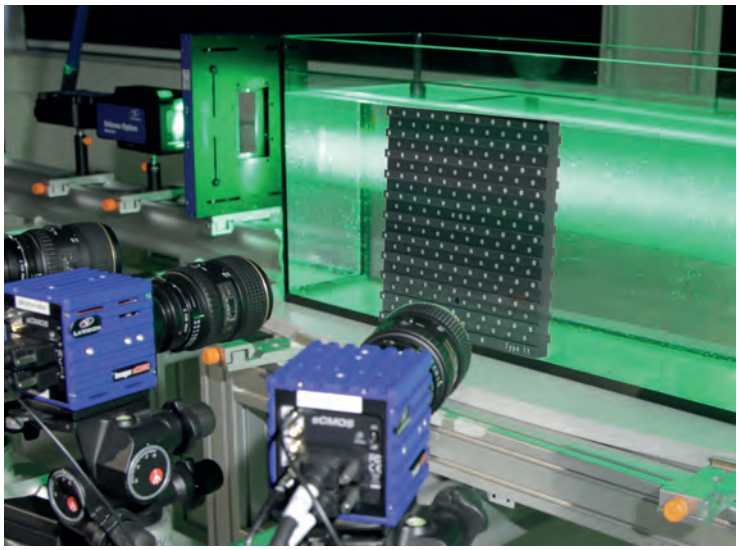
LaVision's **GPU** based PIV algorithm does not require you to learn any new processing details. Most functions and parameters are available 1:1 in the conventional CPU and the new **GPU** processing schemes, such as multi-pass correlation, tomographic reconstruction and correlation, and PIV uncertainty calculation.



GPU for Stereo-PIV



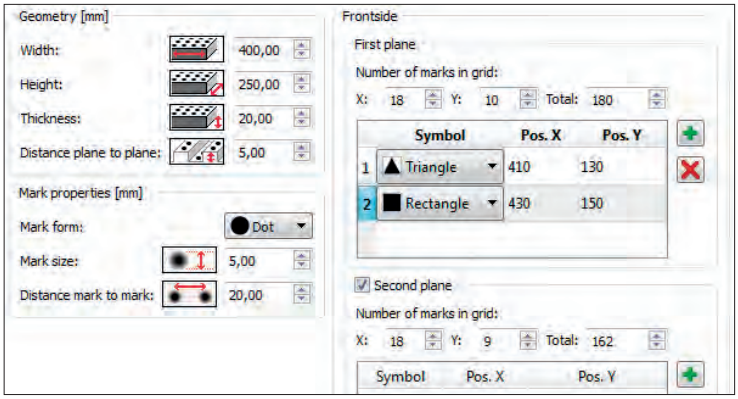
GPU for Tomographic PIV



Calibration of a volume measurement (Tomographic PIV) in a medium, using a single snapshot of the 3D calibration plate

Design your own calibration plate

LaVision provides a large range of calibration plates, starting from micro calibration plates up to more than 1 m. If you intend to use an own calibration target design, **DaVis** allows you to define that in the calibration wizard. A calibration plate configurator supports single or double level (3D and double sided plates) with a large variety of patterns and formats.



3D Calibration Plates

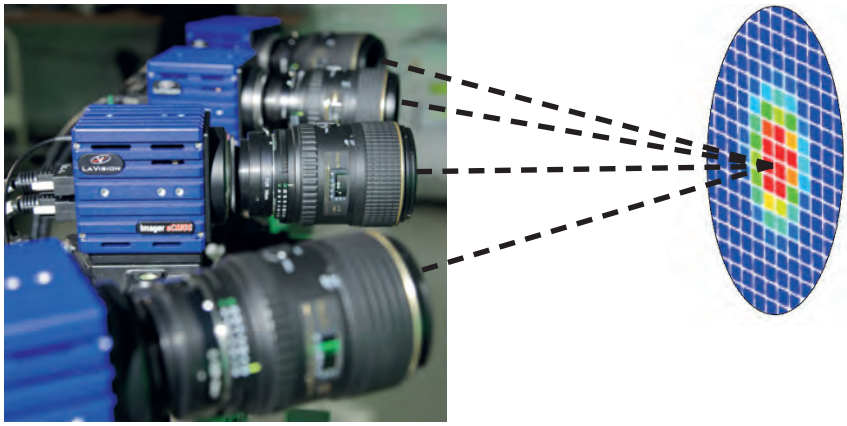
The two-level double-sided 3D calibration plate allows calibration of a stereo (Stereo-PIV, Stereo-DIC) or volume (Tomo-PIV) setup with only a single view calibration. Taking a single image from one target position is sufficient to calibrate the entire volume.
In contrast to widely used flat calibration targets, physically scanning the volume or taking several views is not required.
The 3D calibration plates are active on both sides, so that camera views from any side of the measurement region are possible.
This feature is extremely convenient, when the measurement plane is difficult to access, like in a basin or heat chamber.

Calibration

Spatial calibration of a camera system is an essential step in a measurement. In a typical setup, a single camera or multiple cameras are arranged to view the measurement area from a certain position often under an oblique angle. Through the calibration procedure **DaVis** knows the physical positions of all cameras, the image scale and any optical distortions.
The calibration procedure is as straightforward as taking a picture of a known calibration plate. **DaVis** measures the locations of calibration marks on the calibration plate and reconstructs the transformation from true space to a camera image. A software wizard guides you through the few calibration steps and gives feedback about the calibration quality.
As a result, **DaVis** can dewarp the camera images in a way that they appear unskewed. Images from multiple cameras looking under different oblique angles or from different sides to the measurement object, can then be superimposed with sub-pixel precision. Typical optical distortions as they appear with wide angle lenses, endoscopes, or when viewing through curved glass surfaces, are corrected as well.

Features of calibration in DaVis

- dual side calibration plates
- automatic mark search
- pin-hole model or polynomial fit
- calibration plate configurator for custom designs
- calibration history for full traceability
- up to 8 independent coordinate systems
- 3D view of calibration scene

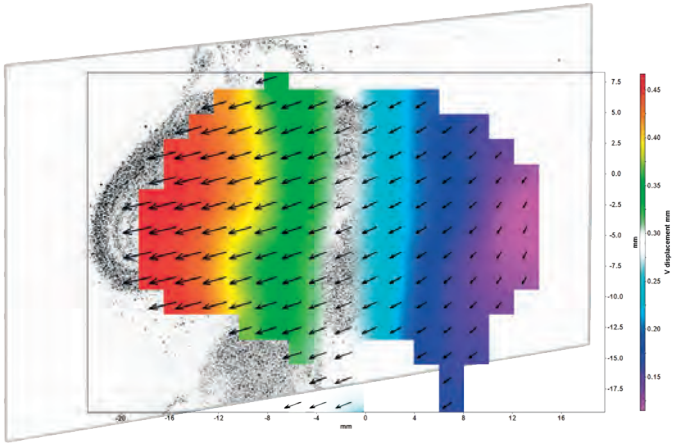


Self-Calibration

LaVision has developed algorithms for an easy and quick calibration. The 'Self-Calibration' method is a unique tool to correct even large misalignments between calibration plate and laser light sheet with the recorded particle images themselves used to calculate this misalignment. The mapping function is corrected accordingly and the recorded images are evaluated. LaVision's **Self-Calibration** method is a standard feature of LaVision's Stereo-PIV software **DaVis**.

Benefits of Self-Calibration

- **higher accuracy**: elimination of calibration errors
- **user-friendly**: free positioning of calibration plate, no need to align calibration plate exactly with light sheet
- **easy volume-scanning**: all scanning positions calibrated at once
- **easy access**: possible to place the calibration plate outside the measurement volume
- **time-saving**: calibration can be prepared off-site
- **additional benefits**: information on relative position and thickness of both laser sheets



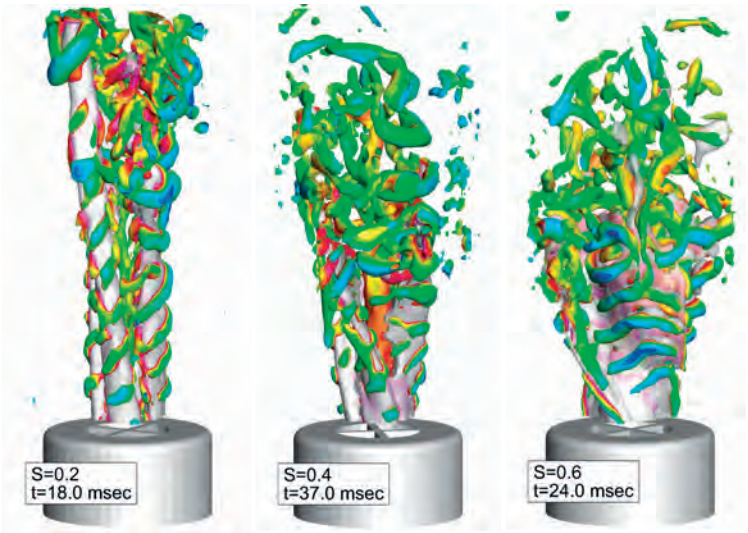
Disparity map corrects the laser sheet position.

Volume Self-Calibration

When reprojected from the calculated 3D cloud back onto the 2D camera space, particles in the volume are observed as being imaged at slightly offset positions. Averaging these differences for many particles in a local sub-volume, 3D disparity maps are generated and the calibration function is corrected accordingly.
This widely accepted **Volume Self-Calibration** procedure provides a check for and a remedy of possible calibration problems and is an **indispensable pre-processing step for Tomographic PIV**.

Features

- refines the camera position to <0.1 pixel accuracy
- compensates changes in practical experiments due to temperature or vibration
- allows volume data at highest information density
- drastically suppresses artefacts from ghost particles which arise even from sub-pixel disparity in larger volumes
- gives quantitative feedback on calibration quality
- **patented*** **technology**, developed at LaVision



High-resolution Tomo-PIV images, enabled by Volume Self-Calibration, courtesy of F. Scarano, TU-Delft.

* Patents: EP 1 926 049, US 8,120,755

PTU X

With its very successful predecessor PTU 9 LaVision marked a milestone in managing complex trigger schemes with multiple devices under challenging conditions, like unevenly running engines or shock tubes. With **PTU X** LaVision takes the next leap in comprehensive triggering.

The **PTU X** is the heart of all **DaVis** 8 systems. It generates precise trigger pulses for the cameras, lasers and devices controlled by **DaVis**. Low-speed and high-speed camera systems can be triggered from the same device by switching between internally stored application optimized firmware.

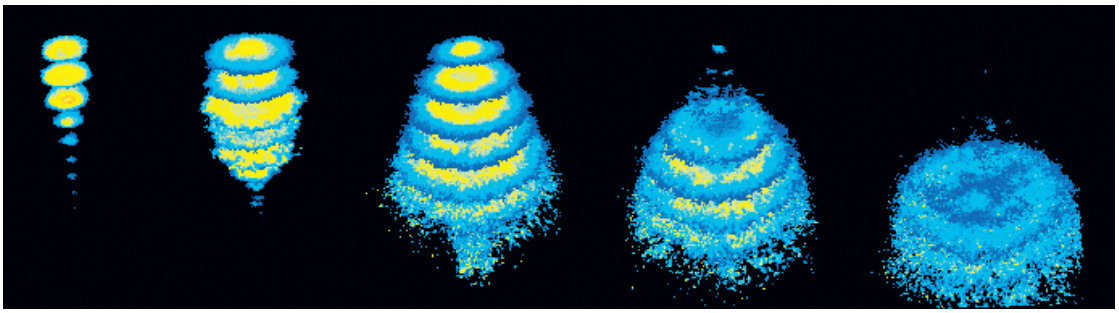
Features

- fully synchronized recording of mixed camera and laser types with other devices
- phase locking and phase scanning for periodic events, including rotary encoders for engine test beds
- continuous rate mode and frame straddling mode for time-resolved PIV measurements
- independent timing groups (reference times) and user defined trigger solve even complex trigger designs
- trigger prediction for periodic triggers allows “negative” delays
- multi exposure for improved S/N ratio with intensifiers
- Graphical Connector Interface (GCI)
- in-system firmware updates keep the PTU up to date with innovations

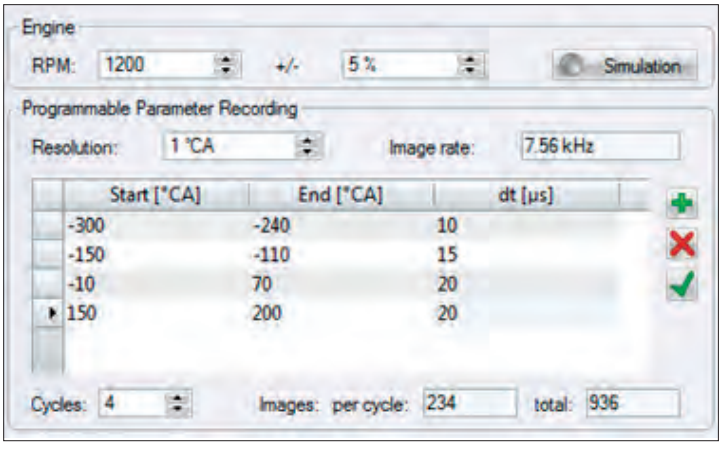
High-speed cameras

The **PTU X** combines the advances of time resolved measurements with the outstanding trigger and recording capabilities of **DaVis**. Close cooperation with the main high-speed camera manufacturers guarantees highest performance.

- full integration and control of multiple high-speed cameras
- mixing of different camera models in the same system
- application specific measurement domains simplify the system setup
- hypersampling for engine applications remaps time to crank angle basis



Combined time and space scan of a pulsed GDI spray using the PTU for triggering and a motored traverse to position the light sheet



Programmable Parameter Recording (PPR)

PPR addresses the necessity to change the PIV Δt when the flow situation changes drastically over a short time, like for IC engine internal flow fields or unstable convection phenomena.

While capturing PIV images with high-speed cameras, the inter-frame time will be automatically changed during recording and therefore, adapted to rapidly changing flow conditions. It is proven that variable PIV Δt settings are necessary for intra-cycle PIV data acquisition in engines.

Cameras

DaVis controls more than 70 different CCD, sCMOS and CMOS cameras, including more than 25 high-speed camera models. LaVision constantly implements selected models to provide state-of-the-art camera technology.

Camera RAM

Making use of the huge possible RAM on 64 bit Windows, the computer's RAM can be used as a very fast buffer. The camera RAM feature allows recording images from a larger number of cameras directly into the RAM at highest image rates before it is safely stored onto the hard disk.

Intensifier (IRO)

Image intensifiers increase the light sensitivity of a common camera to single photon response. LaVision has built up the fundamental knowledge about the technology from the early beginning.
DaVis features for intensified systems:

- precise timing control of delay and exposure
- intensifier gain control
- automated camera sensor exposure according to phosphor decay time
- multi exposure feature collects several IRO exposures on the same camera image to improve signal-noise-ratio (on-chip integration)

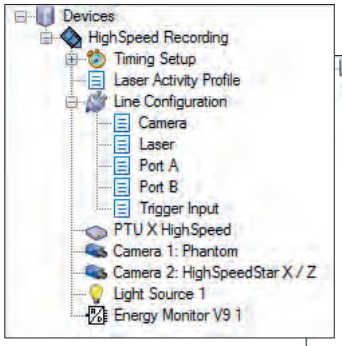
HighSpeed IRO

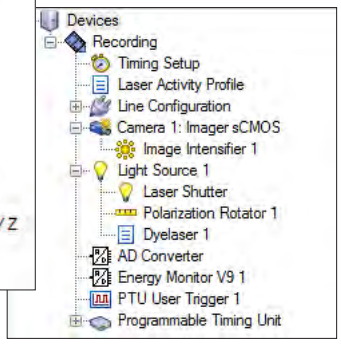
The high-speed models of LaVision's intensifiers contain additional boost stages to override gain depletion in the micro-channel plate (MCP). **DaVis** fully supports intensifiers for high-speed systems, laser based or for self-emission.

Remote optics

Selected lenses and LaVision's Scheimpflug adapter can be remote controlled by **DaVis**:

- focus and aperture
- Scheimpflug angle
- access to optics from remote places
- highly integrated imaging modules for underwater PIV systems





Laser control

DaVis controls all common laser models, especially flash-lamp and diode pumped Nd:YAG and Nd:YLF laser.
Software integrated modes for standby, operation during image acquisition and for laser alignment match the needs of a typical workflow during setup and operation of a laser up to safety class 4.

- additional standby and alignment modes
- laser power control by flashlamp Q-switch timing, attenuators or lamp energy (depends on model)
- automated laser shutter control to improve lab safety, UV output stability and dye lifetime
- dye laser wavelength scan with fully automated control of higher harmonics and peak finding

How does DaVis store data?

Data handling is an essential part of **DaVis** functionality. LaVision has optimized the custom file format in **DaVis** according to the needs of large data sets in combination with meta-information stored along with image data. Images arising from a number of cameras from the same exposure are stored together in our “im7”-file format, including double image frames from PIV measurements and timing information. For vector-type results, such as from PIV, LaVision developed the vc7-file type, which can hold 2D and 3D vector data.

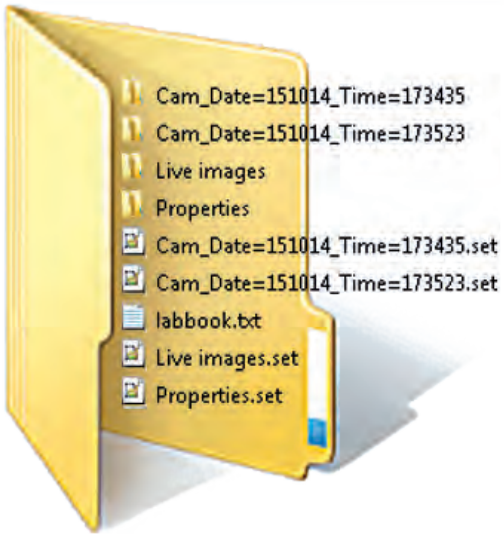
To simplify handling the typically large number of image files, all images belonging together are collected in **DaVis** sets. This could be a recorded series of a few 1000 images or the result of processing PIV vector data.

64 bit

From the beginning **DaVis** 8 was designed for a 64 bit operating system. You can make use of very large RAM installations in a PC to record comparatively long sequences directly into the computer’s memory at a high rate. A state-of-the-art Stereo-PIV system can easily generate 1 Gbyte of data per second. System performance can significantly improve, if sufficient RAM is available and accessible. **DaVis** 8 delivers all necessary 64 bit drivers for your system’s hardware. LaVision works closely together with selected manufacturers to improve hardware availability and accessibility.

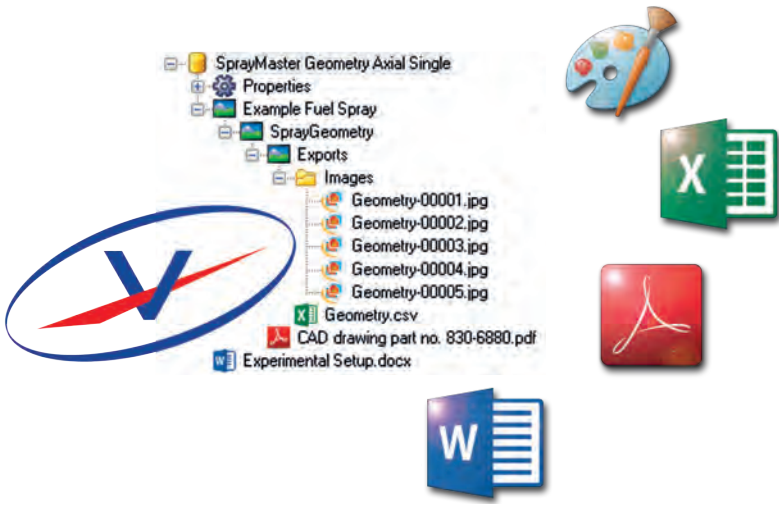
Open format

LaVision provides free programming tools to access **DaVis** data in applications other than **DaVis**. For the most requested programs, MATLAB® and LabView® sample code and DLLs are available. A C++ library for direct data access allows you to program data access for your own application.
A simple macro language in **DaVis** gives you access to every pixel of any image and powerful processing routines.



Additional file formats

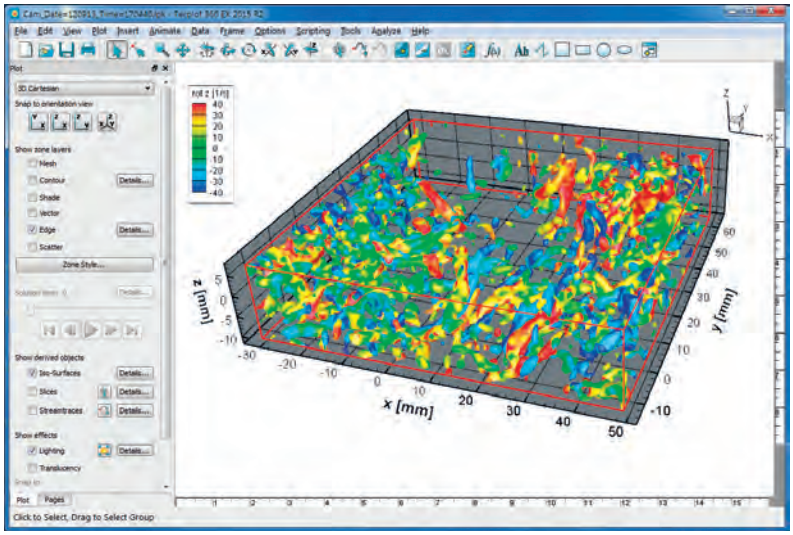
You can add any additional type of file to your **DaVis** data. If you have images, Word™ or Excel™ files or any other file type, simply add them in the **DaVis** data browser. This keeps all files together right at the location you need them.



Free Add-Ons

LaVision's file formats for data storage of images and vector fields are optimized for the needs of multi-parameter laser imaging systems with multiple cameras and other data sources.
Since the beginning, LaVision has kept the files accessible in the public domain without the need to run the **DaVis** application

- processing **DaVis** data in MATLAB®
- use Tecplot® 360 Add-On for outstanding graphical presentation of 3D data
- design you own application using the C++ **DaVis** API



Tomographic PIV result presented in Tecplot®.

Free Tecplot® Add-On

The **DaVis** Tecplot®-Add-On provides the import of **DaVis** IM7/VC7 files in your Tecplot® software and adds a toolbox for advanced vector field calculation.

Features of Tecplot® Add-On

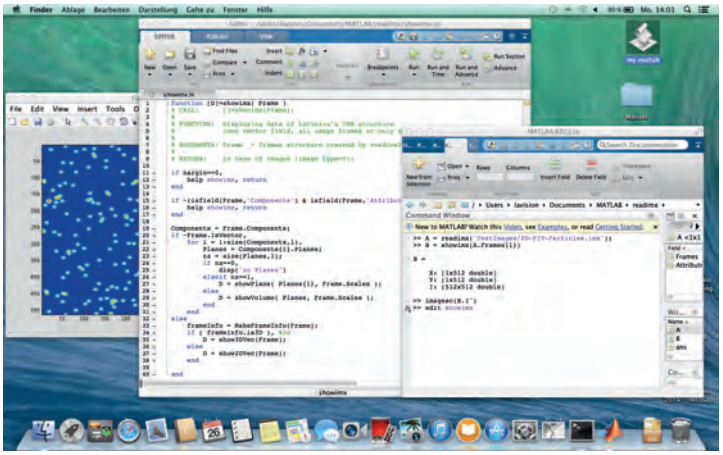
- importing **DaVis** IM7/VC7 files formats in Tecplot® without loss of data
- full Tecplot® access to grids, image or vector data and frames attributes
- preserving **DaVis** frames structures (frames zones)
- toolbox for the calculation of- vector magnitudes (2D/3D)- divergence and vorticity (2D/3D)- 3D swirl (lambda-2, 3D)
- uploading multiple files at once
- MSI package for easy installation

Free MATLAB® Add-On

The MATLAB® Add-On grants access to structures like buffers, frames, components, planes, scales, and attributes. Get started easily and introduced in the new data model by using the example code (Mfiles) delivered with the free package.

Features of MATLAB® Add-On

- supports Mac OS, Linux and Windows
- read and write **DaVis** files from MATLAB®



Opening DaVis data in MATLAB® on a MacBook.

Free DaVis API

A free API for C++ allows you to program your own application accessing **DaVis** files.

- source code (C++) to read and write **DaVis** image and vector files of formats IM7, VC7, IMG, IMX, VEC
- compiles on Windows and Linux systems

Free use of the Add-Ons:
The Add-Ons are free to use without any **DaVis** license. A 3rd party license for MATLAB®, Tecplot® or a C++ development environment is required.

DaVis – leading edge PIV algorithms

LaVision has a long history of providing and constantly improving our PIV algorithms. Scientific cooperation with leading research institutes in fluid dynamics keeps us at the front of development and assures the high quality of our code's results. We strongly believe in our goal of achieving the highest accuracy and precision of the flow fields calculated with our PIV code.

The **FlowMaster** PIV software package offers several features for highly accurate 2D and 3D particle image evaluation. New features are added continuously by LaVision's software engineers and by contributions from the PIV community, using the open CL macro interface.

- high precision adaptive multi-pass stereo-PIV algorithms
- wizard guided stereo-PIV self-calibration
- correlation with dynamically deformed interrogation windows
- correlation vector calculation by sum-of-correlation planes
- adaptive masking with arbitrary shape
- vector field post-processing, e.g. rotation, divergence, stress
- high-accuracy sub-pixel interpolator avoids peak-locking
- Proper Orthogonal Decomposition (POD)

Time-resolved PIV

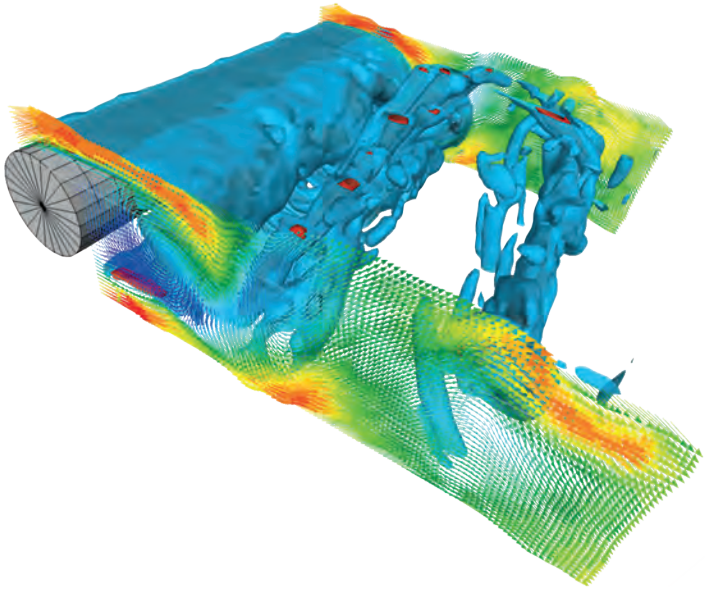
TR-PIV makes use of the information hidden in time correlated data, such as from high-speed cameras.

- time super sampling generates intermediate vector maps for tracking coherent structures
- pyramid sum-of-correlation increases the dynamic range of measurable velocities
- time based filters remove background, reflections and second order scattering

PIV uncertainty

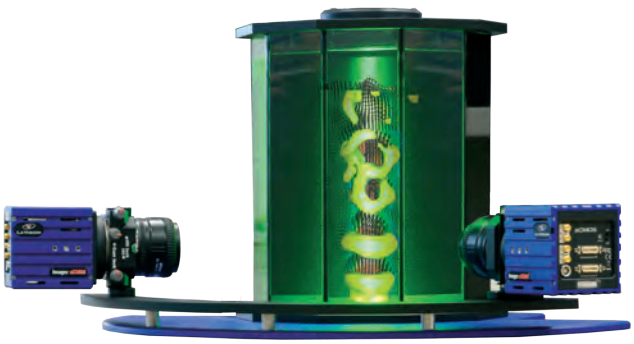
As with any other measurement technique it is necessary for PIV to estimate the associated errors ('uncertainties') for individual computed velocity vectors and derived quantities.
Both systematic and random error sources are minimized by recent developments in processing algorithms but can be further reduced by optimizing the experimental setup.

- uncertainty quantification based on correlation statistics
- uncertainty propagation for derivatives
- gives feedback to optimize PIV parameter settings



Tomographic PIV

The first Tomographic PIV publication in 2006 triggered a real surge in the interest of the scientific community.
This surge is best evidenced by the ever growing number of publications, dealing with the development and, increasingly, with the application of tomographic PIV. Taking an active part in the ongoing process of innovation, our strategy is to make the benefits of innovation available in the easy-to-use environment of **DaVis.**



Features

- MART - robust volume reconstruction algorithm
- Volume Self-Calibration allows highest resolution
- Motion Tracking Enhancement (MTE) for time-resolved data
- advanced volume masking
- Fluid Trajectory Correlation

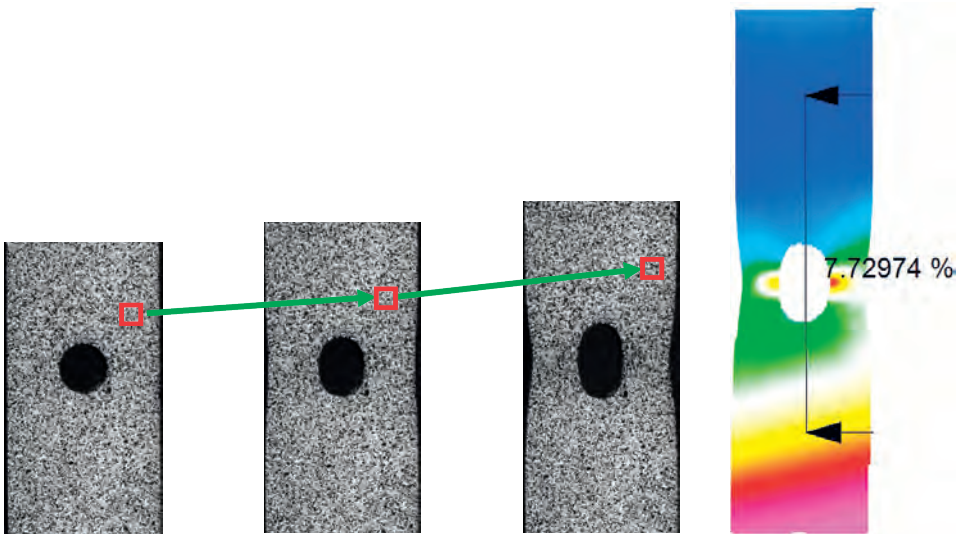
Lagrangian particle tracking

- Shake-the-Box at highest seeding densities
- highest possible resolution tracking of single particles

StrainMaster Digital Image Correlation (**DIC**) systems from LaVision offer a non-contact technique to measure material surface shape, deformation and strain. **DIC** allows the user to obtain accurate full-field data maps of the material surface via this camera based technique, and is appropriate where contacting gauges or extensometers are difficult or impossible to use.

StrainMaster DIC software features

- exceptional strain range – measure from microstrains to 1000% strain
- use with cooled or heated specimens in environmental chambers
- calibrate with a single view of the special two level plate
- full control of all hardware including kHz cameras
- suitable for all types of test - tensile, compression, fatigue, blast, cyclic
- easy to use workflow and full data management of the collected images and results
- FEA data format export for comparison with simulation



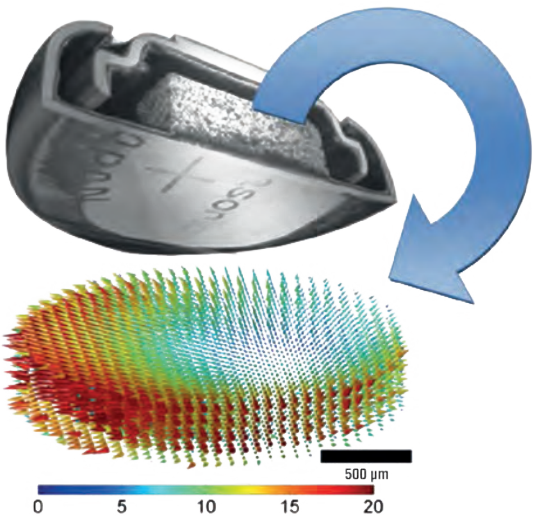
Applications

- combine with IR cameras to correlate heating effects and strain hotspots in automotive parts
- study the shape and aeroelastic responses of locust wings during flight
- utilize high-speed cameras in combination with **DIC** to understand blast effects on civil structures
- investigate composite panels in compression and locate sub-surface damage
- detect defects and discontinuities in the image before they are visible and map crack initiation and propagation in brittle materials

StrainMaster Digital Volume Correlation (**DVC**) takes image correlation beneath the surface and calculates full volume 3D strain and deformation results from a sequence of volume images. Like DIC, images of the specimen in a reference state and loaded state(s) are required. Volume images are typically acquired from X-ray Computed Tomography (X-ray CT) systems, but can equally be obtained by Magnetic Resonance Imaging (MRI) systems for biological subjects, or via optical tomography for transparent media; for which LaVision offer our patented tomographic reconstruction algorithms as an Add-On.

StrainMaster DIC software features

- full volume displacement and strain results
- calculation of over 1 million displacement vectors possible
- no software limitation on volume image size
- displacement accuracy down to 0.02 voxel
- rotation and translation correction to remove rigid body shift between scans
- not restricted to one volume imaging type – import images from any source in RAW format



SprayMaster software packages

SprayMaster software packages are designed for a wide range of spray imaging applications, including spray patternation, plume geometry, planar droplet size distribution, and evaporation.
Quality control systems drastically reduce spray pattern testing costs with an automated workflow and obtain traceability of results.

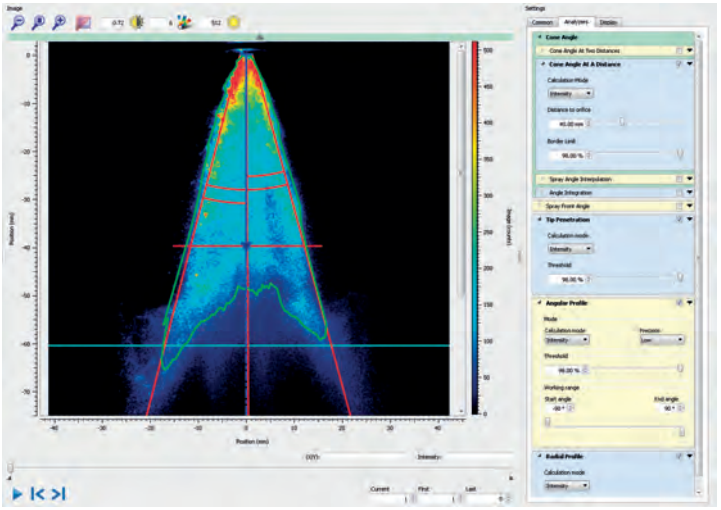
SprayMaster systems can be upgraded with laser imaging techniques for 2D and 3D measurements of spray density, Sauter Mean Diameter or evaporation.

- global droplet sizing (D_{32}) with LIF/Mie ratio imaging
- Exciplex LIF for liquid-vapor phase separation
- 3D spray imaging from tomographic reconstruction

Spray plume and pattern geometry analysis

The **SprayMaster** geometry package extracts spray plume geometry and spray pattern information from shadow and light sheet spray patterns and replaces conventional patternation by an optical measurement.

- spray cone angle, bent angle and half angles indicate the symmetry and direction of the spray plume
- tip penetration to represent the propagation of the spray
- multi-hole spray analysis of repeatability and uniformity
- spray pattern area and diameter
- mass circle diameters according to SAE definition
- radial and angular spray distribution to reveal the structural characteristics of spray plumes



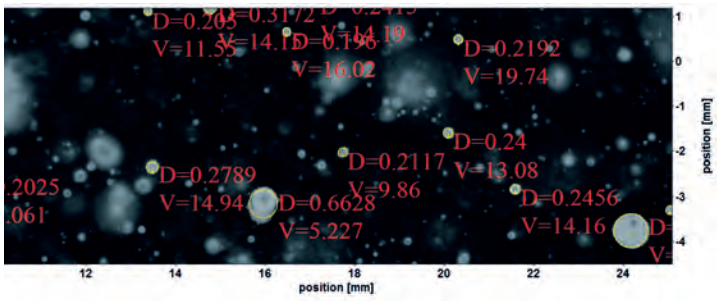
Particle sizing

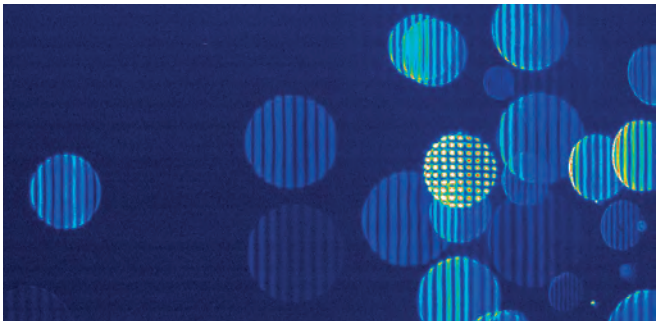
The **ParticleMaster** system measures the individual size, shape and velocity of droplets, particles and bubbles dispersed in air, gas or liquids. **DaVis** supports two complementary sizing techniques for particle imaging: Shadowgraphy and Interferometric Mie Imaging (IMI).

Shadow sizing

The **ParticleMaster Shadow** software package analyses highly magnified shadow images of individual particles or droplets in a variety of sprays and particle-laden flows.

- particle size, position and shape
- particle number density
- statistical data evaluation: histograms, scatterplots
- particle velocity derived from double frame exposures
- integrated report generation





Interferometric Mie Imaging (IMI)

The **ParticleMaster IMI** technique is optimized for spray investigations of smaller droplets at low and medium droplet densities.

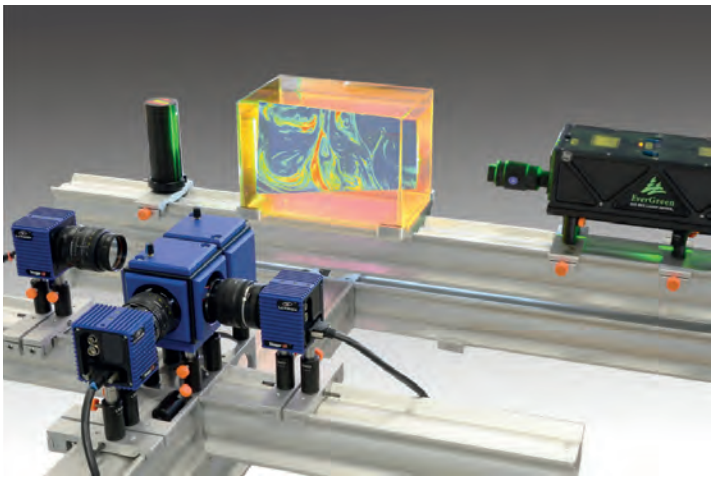
- auto-detection with droplet location from a single camera
- particle size from fringe pattern analysis

FluidMaster for non-reactive flows

Concentration of chemical components, temperature and mixing degree are the main topics to be measured in non-reactive flows, either in liquids or gases.

DaVis supports these mainly via **Laser Induced Fluorescence** (**LIF**) approaches based techniques during data acquisition and image processing. **DaVis** manages the camera signals, the different image types (background, laser sheet, intensity calibration).

The integrated image preprocessing routines account for background offset, variations in signal gain, laser sheet intensity distribution, laser pulse-to-pulse fluctuations, vignetting and image distortion. The result of these image preprocessing routines is a flawless 2D image of the laser induced signal.

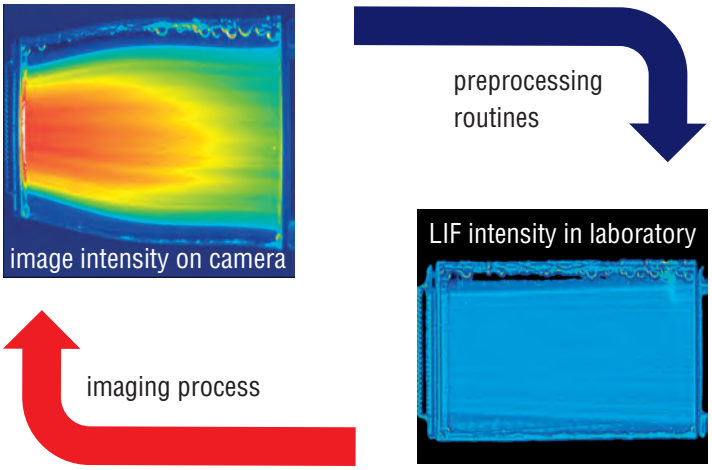


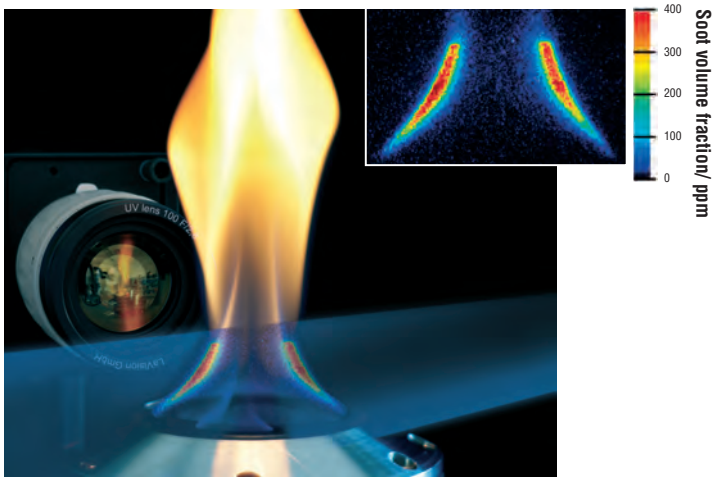
Applications

- temperature in liquids and gases
- mixing and concentration
- air-fuel ratio
- pH-value, dissolved O_2

Features

- ratiometric 2-color approach
- absorption correction
- corrections for energy, light sheet, background
- calibration to physical units





Combustion Analysis

- 3D flame imaging
- soot concentration with Laser Induced Incandescence (LII)
- gas and flame composition and temperature with Raman
- 2D temperature in flames with Rayleigh
- molecular species detection with tunable laser LIF

FlameMaster for combustion and flames

DaVis supports a complete set of advanced imaging techniques for concentration and temperature measurements in reactive gas flows and combustion systems. The specific software packages provide highly flexible image acquisition modes synchronized with control of sophisticated hardware devices, and allow easy use of laser imaging systems from LaVision.

Laser Induced Fluorescence (LIF)

LIF is highly species specific and is the laser imaging technique with the highest sensitivity. The LIF package supports accurate and quantitative signal detection.

- laser sheet and image correction
- compensation for pulse-to-pulse laser fluctuations
- LIF signal calibration
- multiple calibration points with curve fitting
- laser absorption compensation for intensity correction
- dye laser scan & peak-finding

License and Installation

Analysis license

The analysis license is a cost-effective way to give more flexibility in data processing. It grants access to all **DaVis** platform functions together with the processing capabilities of the purchased modules, without the cost of including hardware control.

Network license

A network dongle is installed on a central server in the local network. The associated license gives access to a defined number of users simultaneously connected to the server.

Multiple DaVis installations on the same machine

DaVis has a unique philosophy for its software installations: it can be installed in individual folders without using any hidden registry entries. This possibility means, that you can have multiple copies on the same PC by simply duplicating the **DaVis** program folder. With **DaVis** installed several times on the same machine, you can configure each copy for a different purpose, e.g. different hardware. Making a backup of **DaVis** is as simple as copying the entire program folder to a safe place.

Flexible usage of your license

LaVision provides two types of **DaVis** licenses: A hardware license allows **DaVis** to run all hardware components and enables recording and processing of data. An analysis license solely for processing data is available at a reduced cost.
Each license is bound to a physical license dongle (USB), which can be connected to an unlimited number of computers. This license policy gives you a maximum of flexibility while keeping costs at the minimum necessary level.

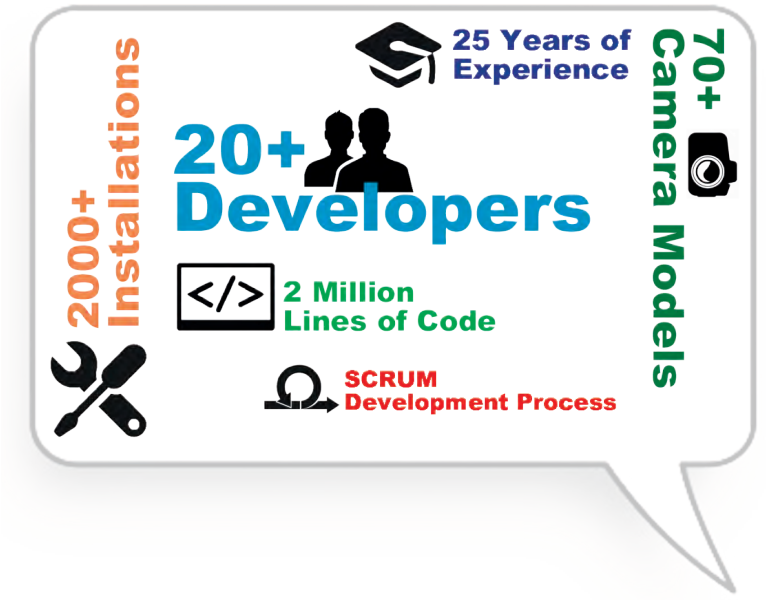
Example data

The best way of learning a new software is practicing on examples. A free copy of a comprehensive collection of example data including project files of all major application packages is available on DVD.

The history of DaVis

DaVis came in the early 90s from a MS-DOS program for camera readout. Even this early version had scripting capabilities which laid the cornerstone for software open to user programming. The first „**DaVis**“ had version number 5, worked directly on image buffers (img and imx format). With PIV the first sophisticated algorithms lead to a constant improvement of **DaVis**.

first MS-DOS based camera software	WIN SC 4 1st Windows	DaVis 5 Stereo-PIV	DaVis 6 PTU triggering	DaVis 7 Project concept	Tomographic PIV
1989					**DaVis: constant innova**



Your support is our passion

Free lifetime support

Every **DaVis** license includes free support through email and telephone for the entire product's lifetime. Our experienced and highly motivated team will quickly respond to your questions and enquiries.

Free lifetime updates

Any update within **DaVis** 8's lifetime is free of charge and can be downloaded from our website. We have several major updates per year, which means you have access to our latest innovations.

Service file generation

DaVis includes tools to allow us to support you easily and quickly. With a few mouse-clicks you can generate a service file, which contains all information about your actual **DaVis** settings.

Training and Seminars

Software training

During system installation our engineers provide onsite training on **DaVis** in order to give you the best possible start operating a new LaVision system. Additional training can be booked to support your engineering team.

Application seminars

Get into contact with other **DaVis** users at one of our seminars. LaVision provides courses on applications like PIV or LIF, giving a comprehensive overview about the possibilities of **DaVis**, including hands-on laboratory sessions.

DaVis today

DaVis has evolved into the most recognized software in (Tomo-)PIV, and includes GPU acceleration and the latest algorithms, like PIV uncertainty and Shake-the-Box. It is applied to material science, in near-production quality control environments, and is present in many industrial and research labs worldwide. At LaVision we are committed to continual development of the **DaVis** product and achieving the best possible solutions.

DaVis 8 64 bit | **GPU support** | **DIC and DVC** | **PTU X integration** | **PIV uncertainty** | **Shake-the-Box**

ation for over 25 years **2016**

DaVis
Imaging Packages

DaVis offers several upgrade paths from compact single-purpose tools to multi-parameter imaging solutions to grow with your high end applications.

DaVis 8
- hardware
- high-speed
- analysis
- network

FlowMaster
- 2D-PIV
- Stereo-PIV
- Time-resolved PIV
- PIV uncertainty
- Tomographic PIV
- GPU acceleration

StrainMaster
- 2D-DIC Digital Image Correlation
- 3D-DIC
- Digital Volume Correlation (DVC)

SprayMaster
- spray geometry
- planar D_{32}
- Exciplex
- SLIPI
- mass flux
- quality control customization

ParticleMaster
- particle sizing Shadowgraphy
- Interferometric Mie Imaging (IMI)

FluidMaster
- LIF concentration
- LIF temperature
- absorption correction

FlameMaster
- tunable dye laser
- Laser Induced Incandescence (LII)
- Rayleigh thermometry
- Raman
- Pyrometry

Free Add-Ons
- MATLAB® Add-On
- Tecplot® Add-On
- C++ data access library

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