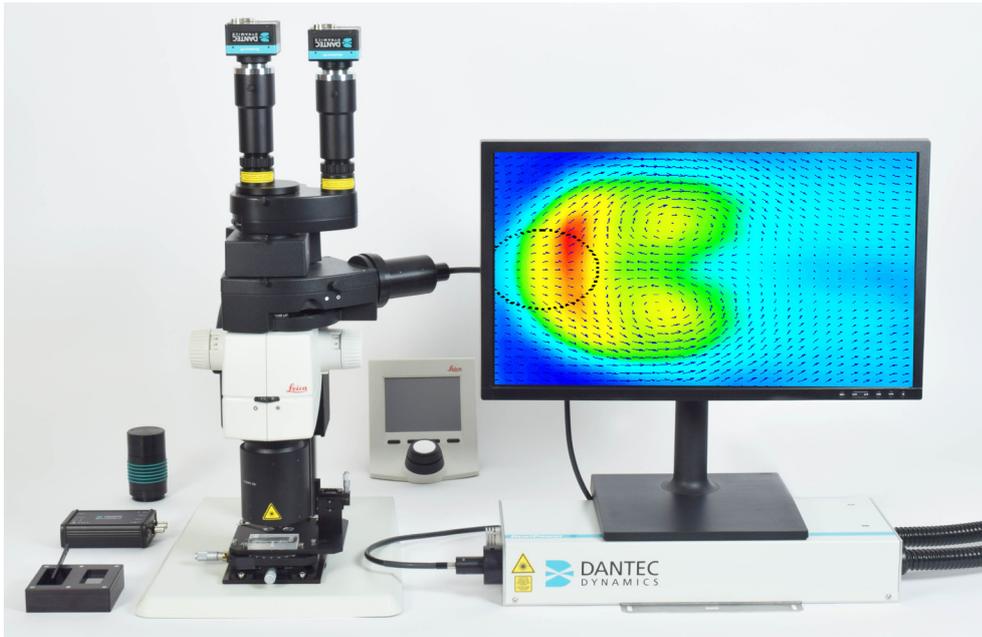


Stereo μ PIV system

All-in-one stereoscopic μ PIV system for 2D3C measurements in micro scale



Stereoscopic μ PIV system for accurate flow measurements in microscale

The all-in-one Stereo μ PIV system from Dantec Dynamics comes with high magnification, high resolution, adjustable field depth control and superior measurement accuracy. A dedicated image calibration kit improves accuracy by providing real calibration images simulating real experimental situations. Three different illumination alternatives increase the flexibility during experiment setup, calibration and measurements. The system is suitable both for conventional dual pulse imaging and for time resolved imaging. In short, the preferred solution to 2D3C velocity measurements in microscale.

Key benefits

- Accurate investigation of flows to validate CFD results or physical models
- Simple all-in-one solution – easy to handle also for new users
- Easy, flexible adjustments reduces experiment setup time
- Saves time on calculations and puts focus on the experiment
- Excellent repeatability and traceability
- Safe laboratory solution in compliance with laser safety regulations
- High degree of flexibility to adapt to different measurement applications

Micro PIV and its application areas

Micro Particle Image Velocimetry (μ PIV) is a mature technique within fluid mechanics that allows for measurement with micron resolution. A conventional μ PIV system provide planar 2-component flow fields (2D2C), however, most microfluidic flows are often 3D in nature.

Stereo μ PIV is the variation of the technique that provide measurement of all three-velocity components (2D3C). With the advances in research into medicine, molecular biology and genetics, investigation of 3D fluid flows has received increased focus.

Relevant and interesting applications include: experiments involving biological flows; validation of MEMS; lab-on-a-chip devices; flow focusing and separation; cell detection and manipulation; assay implementation; DNA purification; protein crystallization; micromixers; droplet and bubble dispensers.



Enhanced focus on microfluidics

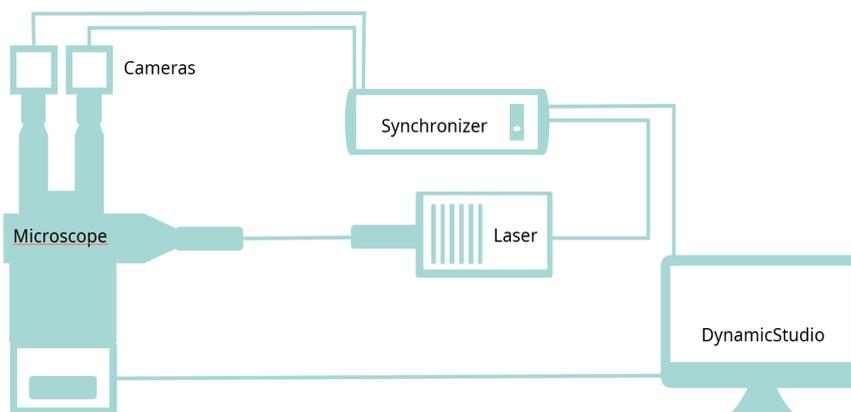
Stereo μ PIV system with a dedicated calibration kit

The Stereo μ PIV system from Dantec Dynamics is the perfect solution for performing velocity measurements in microfluidic devices. The system is optimized for high resolution, high magnification and high measurement accuracy. The all-in-one solution consists of:

- Stereo microscope with control unit
- LED illumination for calibration
- Laser illumination for measurement
- Cameras
- Calibration kit
- System computer and synchronizer
- Software (DynamicStudio)
- Microfluidic device



Calibration kit



Overview of a Stereo μ PIV system.

To provide the planar 3C flow field a stereoscopic image calibration of the system is required. Positioning a calibration target in a microfluidic channel is quite challenging. Therefore, the Dantec Dynamics solution comes complete with a dedicated calibration kit and dedicated illumination device that makes it possible to perform proper stereoscopic image calibration. Thanks to this unique calibration kit the all-in-one Stereo μ PIV system is the right solution for microfluidics researchers who want the absolutely best accuracy during flow investigations in order to validate CFD results or physical models.

The system components

Stereo microscope

The microscope configuration is carefully selected and modified for the requirements of an accurate Stereo μ PIV measurement. The microscope features fully plan apochromatic corrected optics, 16,5:1 zoom ratio, a double-iris diaphragm to control the field depth, an optional objective slider to switch to conventional 2D

imaging, white LED illumination, and different options for C- and F-mount camera adapters.

The total magnification range depends on the selected camera adapter: It is possible to get 1x-18x and 2x-36x magnification range for C-mount cameras, and 3.6x-57.6x magnification range for F-mount cameras. The magnification can be changed continuously for flexibility or step-wise for repeatability.

A motorized hand control unit is included in the configuration for ease of use and for display of coded functions. Zoom, iris diaphragm and the common main objective is coded in the control unit. The coding allows accurate documentation of magnification, field of view, depth of focus and resolution. This means reproducibility and consistency in experimental procedures and permits calibrated measurements at all zoom levels.



Control device with display for easy motorized control of microscope

LED illumination

Two separate LED illumination systems are integrated in the microscope configuration: A continuous white LED illumination for quick alignments and a pulsed focused green LED illumination for the calibration process. The intensity of both light sources can be adjusted manually or through the software.

For slow microfluidic flows in transparent samples with less than 100mm/s velocity, the Microstrobe LED illumination can be used in transmission mode. This compact, dedicated, low cost, pulsed and focused LED illumination eliminates all the laser safety requirements ensuring a completely safe operating environment for the researcher. LED illumination also allows the investigations of biological flows without destroying the live organisms.

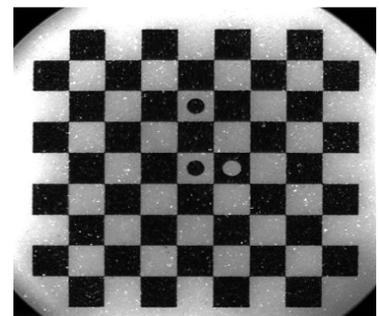
In addition to the LED illumination a number of high- and low-repetition rate PIV lasers are compatible with the microscope. The low-repetition rate PIV lasers can be used for measurements in steady flows, and the high-repetition lasers can be used for time-resolved measurements of transient flows. The light coupling is safely achieved using a liquid light guide. For a complete list of compatible lasers, please consult your local Dantec Dynamics representative.

Cameras

When it comes to camera selection, Dantec Dynamics is the most flexible choice. With more than 100 different camera models supported, it is easy to pick a suitable camera for the experiment's spatial resolution, pixel sensitivity and temporal resolution requirements: This camera range includes CCD, CMOS and sCMOS detectors, from VGA to 29Mpix resolution, up to 70% absolute quantum efficiency (QE) and up to 25600 frames per second. Different C- and F-camera mounts are available to adapt the field of view to the detector size. Please consult your Dantec Dynamics representative for camera selection.

Calibration kit

Stereoscopic image calibration in a microchannel is simply difficult if not impossible. In order to achieve an accurate image calibration we introduce a dedicated image calibration kit, which consists of a calibration target supported by the software, a calibration pool and a micro stage to traverse the target in the calibration pool. Most importantly, the top surface of the calibration pool and the microchannel are the same simulating similar optical paths during calibration and measurements. The calibration target includes two checkerboard patterns for ~1mm and ~0.5mm object size. The checkerboard patterns on the calibration target have good contrast with respect to the background. Carefully placed circular markers allow an unambiguous definition of the planar coordinate axes.



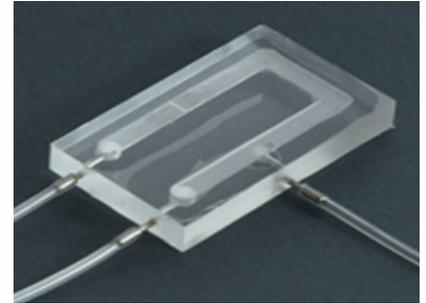
Checkerboard for accurate calibration of microscope

3D microchannel

The microfluidic device has three flow inlets and two regions where one can create 3D flow fields: a 500 μm -diameter hole and a 500 μm -high step. Canonical fluid flows can be observed; i.e. an impinging jet, oscillating jet or a jet in cross-flow using the hole. Similarly, flow over backward facing step, or flow approaching a step can be measured using the 2D obstacle in the 1mm-deep channel. The channel width is 5mm, which allows for an easy optical access even with a high stereoscopic viewing angle.

Viewing 3D results

It can be challenging to find intricate flow details when one is observing a complicated flow field. There are two standard views available to visualize 2D3C vector fields: The first is a 2D view where the u and v components are displayed as vectors and the w component with a color map. The second is a 3D view where all three-velocity components are represented with vectors. The rotatable 3D view (bottom, right) clearly shows a vortex positioned close to one of the corners of the micromixer (top, right).

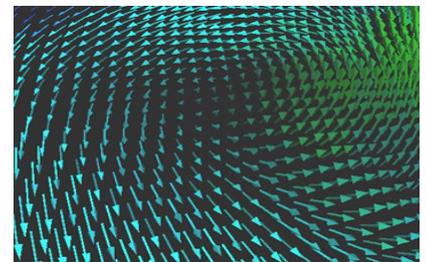


Microfluidics 3D microchannel device

Software

The μPIV system includes a full version of DynamicStudio, which supports:

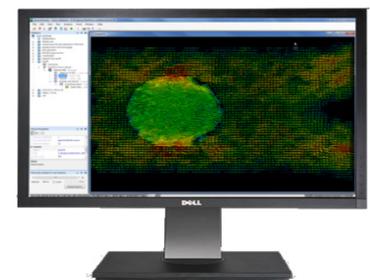
- More than 100 camera models
- Any illumination device through Light Source Wizard
- Distributed data acquisition and distributed data storage
- Easy set-up with plug-and-play connection of cameras, timer devices and other hardware
- Image Processing Library (IPL) – a comprehensive collection of advanced image processing functions
- Proper Orthogonal Decomposition (POD) – advanced energy based flow decomposition
- Stability analysis using Oscillating Pattern Decomposition (OPD)
- MatLab link to perform end-user specified analysis routines scripted in MatLab
- Advanced 2D PIV algorithms: Adaptive PIV and Least Squares Matching (LSM)
- Advanced 2D PTV algorithms based on 3-, and 4-frame tracking
- Calculation of vector derivatives like vorticity, streamlines, and the λ_2 parameter
- Advanced graphical representation of the measured parameters without requiring additional third party software such as Tecplot



3D view of results

System computer

The μPIV system includes a Data Acquisition and Control System, which is preconfigured, tested and ready to use. All necessary hardware and software installation is performed before delivery. The system computer is from an international manufacturer with worldwide presence.



System control with DynamicStudio – the most user-friendly and comprehensive software platform for scientific imaging

Technical Specifications

Specifications	Specifications with standard objective
Magnification range	1.1x to 18x / 2.2x to 36x / 3.6x to 57.6x
Free working distance	20mm standard, others up to 135mm on request
Stereo full angle	~62 degree (in air), ~46 degree (in water)
Online feedback in software	System magnification, field of view, depth of field, correlation depth, filter set, iris position

Order information

Series	Variant	Item no
Stereo microscope	Fluorescence Stereo Microscope with motorized hand controller	9080M0601
LED illumination	Focused microstrobe illumination and electronics for calibration	9080M0611
Calibration kit	Stereo μ PIV calibration kit	9080M0621
3D microchannel	Microchannel for 3D flows (jet in cross flow & flow over step)	9080M0631
2C-3C adapter	Adapter for converting stereo microscope to 2D2C μ PIV	9080M0641
1.1x to 18x	0,5x C-Mount Adapter for Stereo Microscope	9080M0651
2.2x to 36x	1,0x C-Mount Adapter for Stereo Microscope	9080M0661
3.6x to 57.6x	1,6x F-Mount Adapter for Stereo Microscope	9080M0671