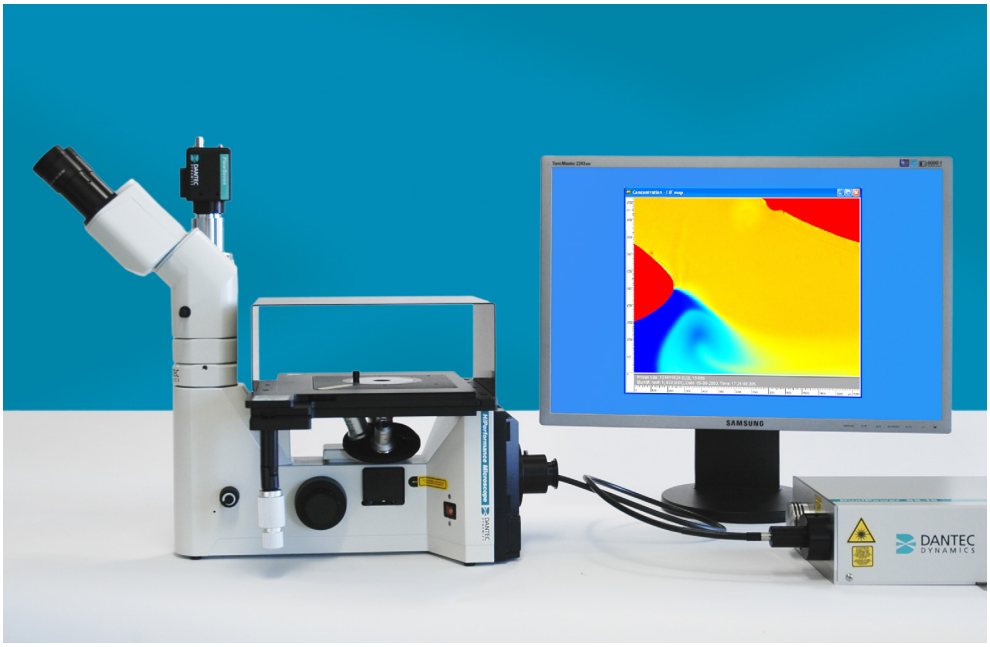
SOLUTION SHEET

MicroLIF system

Concentration, temperature, and pH measurements in micro scale



Dantec Dynamics MicroLIF system, displaying concentration results from a y-type micromixer

MicroLIF system for accurate scalar measurements in microscale

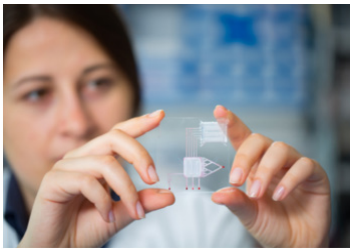
The all-in-one MicroLIF system comes with high magnification, high resolution, and superior measurement accuracy. Different illumination alternatives increase the flexibility during experiment setup, calibration and measurements. The system is suitable both for conventional dual pulse imaging and for time resolved imaging. These make the MicroLIF system suitable for experiments simulating biological flows, validation, and test of flows in MEMS, design and development of Lab-on-chip devices, two-phase flow microsystems, and mixing enhancement studies.

Key benefits

- Integrated solution with safe delivery of laser light
- Optics and dyes optimized for maximum SNR
- Measurements at high optical magnification: up to 100x
- Modular system: easy upgrade to/from conventional PIV or LIF systems
- Time resolved measurements: up to 10kHz

MicroLIF and its application areas

Laser Induced Fluorescense (LIF) is now a mature technique with more than 40 years of application history in fluid mechanics. In this time frame LIF has been applied in different ways to different experiments creating various names for the technique: Planar LIF, 3D LIF, Scanning LIF, Time-resolved LIF, Gas LIF and Combustion LIF. MicroLIF is one variation of this technique that describes measurement of scalar quantities, like concentration, temperature, and pH with micron resolution. With the advances in research on micro technologies, dispersion of species, thermal energy and acidity in micro scales has received increased focus. MicroLIF systems are used to measure species concentration in two-phase flow microsystems; temperature maps in micro-heat exchangers and pH maps in microreactors.



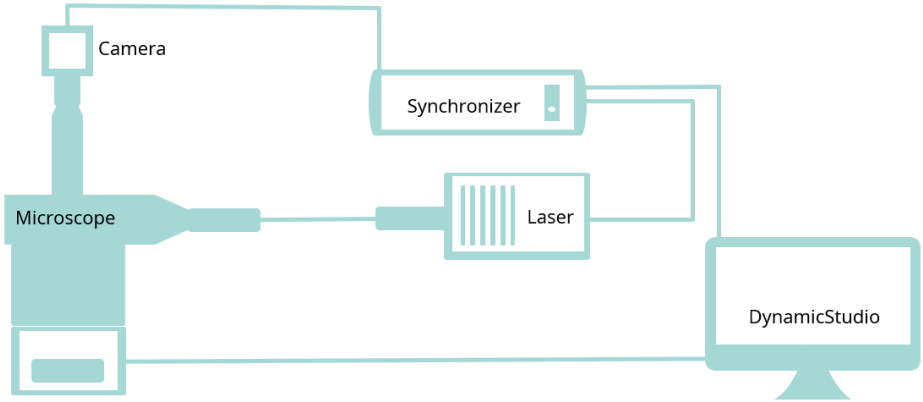
Enhanced focus on microfluidics

MicroLIF system optimized for high SNR

- The MicroLIF system is the perfect solution for performing planar scalar measurements in microfluidic devices. The system is optimized for high resolution, high magnification and high measurement accuracy. The all-in-one solution consists of:

- Inverted Fluorescence microscope
- Laser illumination for calibration and measurement
- Cameras
- Laser safety systems
- System computer and synchronizer
- Software (DynamicStudio)
- Microchannels

With more than 65 years of experience in developing diagnostic tools for fluid mechanics, we have developed a dedicated MicroLIF system for performing scalar measurements in microfluidic devices. The turnkey system is optimized for maximum light transmission and therefore for optimized signal to noise ratio (SNR). The components of the system are designed to make PIV measurements safe and user-friendly, so that the researcher can focus on the experiment and not on the equipment or laser safety.

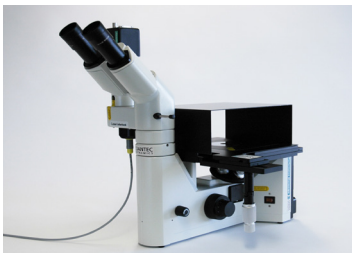


Overview of a MicroLIF system.

The system components

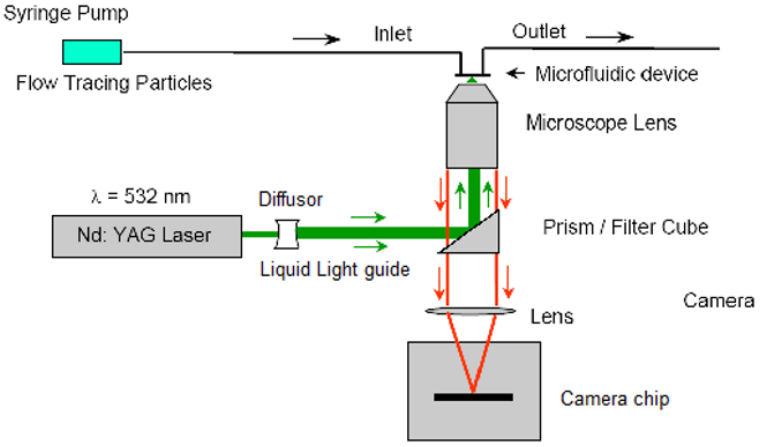
HiPerformance microscope

The microscope configuration is carefully selected and modified for the requirements of an accurate MicroPIV measurement. The HiPerformance Microscope is an inverted fluorescense microscope that is optimized for microfluidic applications. The microscope can be delivered with a manual XY stage or a motorized XYZ stage. Please refer to the separate HiPerformance Inverted Microscope Product Information for details. On request we can implement laser delivery, including a laser safety kit, for other microscopes.



HiPerformance microscope

Filter cubes



Schematic of optical paths in fluorescent microscopy.

In an epi-fluorescence microscope, both illumination and imaging take place through the microscope objective. An optical filter cube reflects the green light from the laser and transmits the broadband fluorescent emission to the camera detector. The performance of the filter cube is optimized for maximum signal to noise ratio (SNR): The optical components in the filter cube are selected to reflect the emission wavelengths, transmit the fluorescent band produced by the fluorescent markers and block the unwanted harmonics involved in the process.

Cameras

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 2.3 to 25Mpix 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.

HiSense Zyla camera with 60% QE.

Illumination

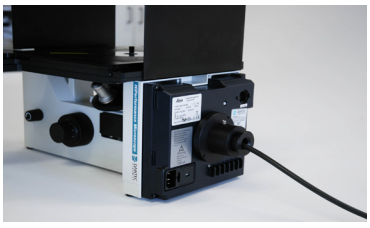
For MicroLIF the illumination mode is often laser illumination, as the laser light is monochromatic and provides good control on the excitation.

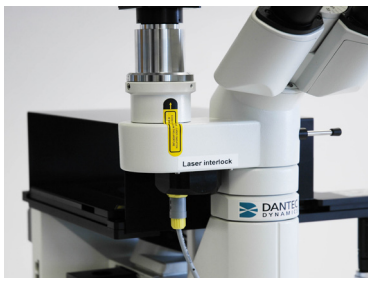
Laser illumination and safety

Several high- and low-repetition rate PIV lasers are compatible with the microscope, which can "freeze" the particle motion in a small field of view. 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.

The MicroPIV system has unique laser safety features:

- A flexible optical guide ensures safe delivery of laser light into the microscope
- Special laser and microscope optics block emission of invisible harmonics
- A cover plate over the translation stage reduces the amount of light above the microscope
- An interlock system ensures that the laser light is never in the eyepieces of the microscope





Standard laser safety features of the MicroPIV system: liquid light guide, laser interlock and safety cover.

2D microchannel

The microfluidic device has two inlets and and one outlet. There are two regions where one can measure 2D flow fields: a Y-junction and a step. Canonical fluid flows can be observed; i.e. channel flow, merging and separating flows or flow upstream and downstream of the step. The channel width and depth is ~1mm, which allows for an easy optical access even with a high viewing angle.

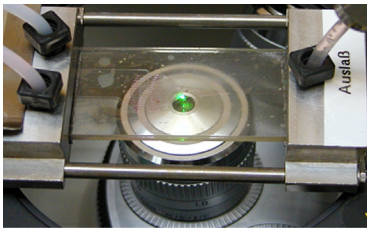
Objectives

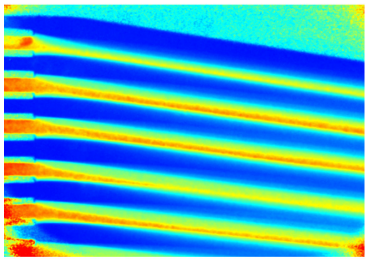
High quality objectives are essential for recording the particle positions accurately in PIV images. In volume illumination, the camera FOV defines the measurement area, but it is the numerical aperture of the microscope objective that defines the flatness and the thickness of the measurement plane.
The microscope objectives are designed to withstand the high-energy laser pulses in the measurement volume. Finally, the green laser emission and broad-band fluorescense emission should be transmitted with minimum loss through the objective. For these reasons, only high-quality dry objectives are used in our MicroPIV systems.

Various magnification objectives

Fluorescent markers

Fluorophore selection is one of the most important steps for obtaining successful MicroLIF results. First, the marker provides a strong fluorescent signal. Second, the excitation and emission wavelengths of the dye are compatible with the rest of the optical system, which is designed to maximise the SNR. Finally, the optimum dye concentration is required to perform eventual LIF calibrations. Usually Rhodamine markers are used for concentration and temperature measurements, whereas Fluorescein is used for pH diagnostics. Because different markers require different excitation and emission bands; different filter cubes are used for velocity, concentration, temperature, and pH measurements.





Concentration measurements in a micromixer (courtesy of IMM Institut für Mikrotechnologie, Mainz, Germany)

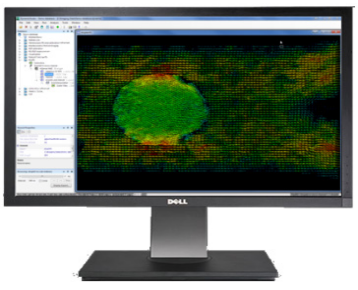
Software

The MicroLIF 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)
- Dynamic Masking addon for better accuracy in two-phase flows
- MatLab link to perform end-user specified analysis routines scripted in MatLab
- Advanced graphical representation of the measured parameters without requiring additional third-party software such as Tecplot

System computer

The MicroPIV 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

Objective specifications						
Magnification	5x	10x	20x	40x	63x	100x
Numerical aperture (NA)	0.12	0.25	0.40	0.60	0.70	0.75
Free working distance [mm]	14	12	6.9	3.3-1.9	2.6	4.7
Cover glass correction [mm]	-	-	0-2	0-2	0.1-1.3	-
Depth of field [µm]	18.5	5.5	1.7	0.9	0.6	0.5

Product overview

Sampling rate	10-15Hz	50-200Hz	1kHz	10kHz
Application	Concentration or tempera-ture analysis	Concentration or tempera-ture analysis. Time resolved measurements in natural con-vection water flows	Concentration or tempera-ture analysis. Time resolved measurements in medium speed water flows	Concentration or tempera-ture analysis. Time resolved measurements in high speed water flows
Laser rep. rate [Hz]	10, 15	50, 100 200	1000	10,000
Camera series	FlowSense EO	FlowSense CX	SpeedSense VEO or VEO E	SpeedSense xx12 series, and xx40 series

Order information

Item	Description	Item no
Microscope	HiPerformance Inverted Microscope for PIV & LIF	9080M0571
Motorized stage	Motorized XYZ stage for HiPerformance microscope	9080M1341
4mm coupling	Laser to Liquid Light guide Coupling. Max 4 mm beam	9080M1351
6.5mm coupling	Laser to Liquid Light guide Coupling. Max 6.5 mm beam	9080M1361
Starter kit	Microfluidics starter kit	9080X2362
5x objective	Objective Lens N PLAN 5x/0.12 WD=14 mm	9138A1201
10x objective	Included in 9080M0571	
20x objective	Objective Lens HCX PL x20/0.40 corr. WD=3.2-1.9 mm	9138A1203
40x objective	Objective Lens N PLAN x40/0.55 corr. WD=3.3-1.9 mm	9138A1204
63x objective	Objective Lens HCX PL x63/0.70 corr. WD=2.6-1.8 mm	9138A1205
40x objective	Objective Lens HCX PL 40X/0.60 Corr. WD=3.3-1.9 mm	9138A1213
100x objective	Objective Lens HCX PL 100X /0.60, WD=4,7 mm	9138A1214
F adapter	1x F-mount adapter for 80M57 Comp. w. Cameras <100mm wide	9138A1216
1x C-adapter	1x C-Mount Adaptor for 80M57	9138A1217
0.63x C-adapter	0.63x C-mount Camera Adapter	9138A1208
0.5x C-adapter	0.5x C-mount Camera adapter	9138A1209
Line target	µPIV Line Calibration Target 0.01 mm Resolution	9138A1218
Grid target	µPIV Grid Calibration Target 0.7mm & 0.07 mm Resolution	9138A1219

DANTEC DYNAMICS Turn Measurements into Knowledge

NOVA INSTRUMENTS