SOLUTION SHEET

DANTEC DYNAMICS

FlexPIV System

Excellent price/performance ratio

Pre-configured, easy to use PIV solution

The FlexPIV is a versatile system for air and water flows, small to medium field of view and velocities up to 100m/s. Great price/performance ratio.

The FlexPIV system allows for non-intrusive measurements of two components of entire flow velocity fields in a plane. It is a complete package to start measuring right away, consisting of a 65mJ DualPower Laser, high-end light sheet optics, a 1.3 MP GigE camera with a C-Mount 35mm f2.1 lens, a GigE interface board, a TimingHub for synchronization, and our advanced software package DynamicStudio for data acquisition, processing, visualization of results and data storage in a secure and robust database structure. The PC for running the software just needs a GigE interface for the camera and a USB port for the TimingHub.

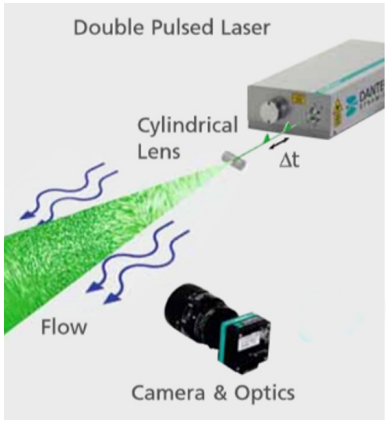
Key benefits

- Versatile, pre-configured PIV system
- Non-intrusive imaging technique for measurements of flow fields in gases and liquids
- Up to 15 velocity fields per second
- Max. velocity 100 m/s
- Min. field of view 37 x 27 mm
- Max. field of view 500 x 370 mm
- Resolves flow structures down to 0.925mm in size
- USB based Plug-and-play synchronizer
- GigE based Plug-and-play 1.3 MP camera
- Laser with attenuator for alignment at low laser intensity without sacrificing beam quality

NOVA INSTRUMENTS

How FlexPIV works

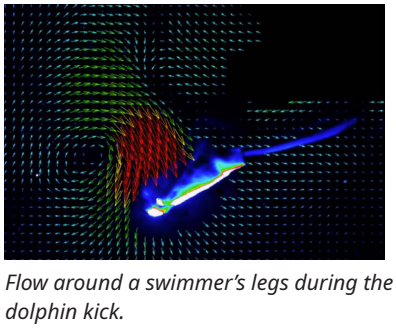
The flow is illuminated in the measurement area with a light sheet. The camera lens images the measurement area onto the sensor array of a digital camera. The camera captures each light pulse in separate image frames.
Once a sequence of two light pulses is recorded, the images are divided into small subsections called interrogation areas (IA). The interrogation areas from each image frame, I1 and I2, are cross-correlated with each other, pixel by pixel.
The correlation produces a signal peak, identifying the common particle displacement, dx, of each interrogation area, with sub-pixel interpolation. Accurate velocity information is obtained by combining the particle displacement and the known time between exposures. A velocity vector map over the whole measurement area is obtained by repeating the cross-correlation for each interrogation area.



A laser light-sheet illuminating seeding particles following the flow. The scattered light from the particles is imaged by the camera.

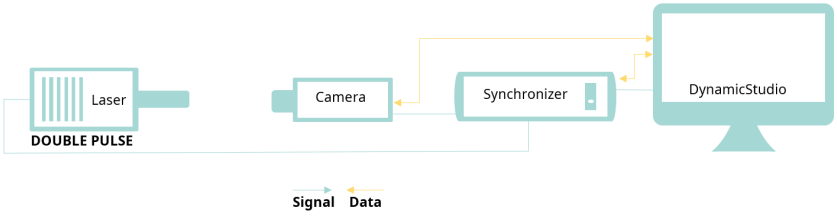
What can FlexPIV measure?

The preconfigured FlexPIV System is designed in such a way that it can handle applications in gases or in liquids, low-speed or high-speed, and small or medium field of view.
The minimum field of view of 37 x 27 mm is great for small scale phenomena.
The largest field of view in liquid applications will be 500x370mm, using 50 µm seeding particles.
The FlexPIV System can measure velocities of 100 m/s even at the minimum field of view. The powerful 65mJ laser in combination with the bright f2.1 lens provides sufficient light for a field of view up to 270 x 200 mm in gas flows, using DEHS as seeding material (droplets of 2-2.5 µ diameter). The high-quality light sheet optics, with a transmission of over 95%, includes angle modules to generate a laser sheet divergence angle between 4° and 12°.
PIV lasers are designed for best performance at their rated pulse energy. The beam quality is affected if the laser is run at lower pulse energy. The laser comes with a motorized attenuator to allow for alignment at low output energy but with the laser running at nominal pulse energy.



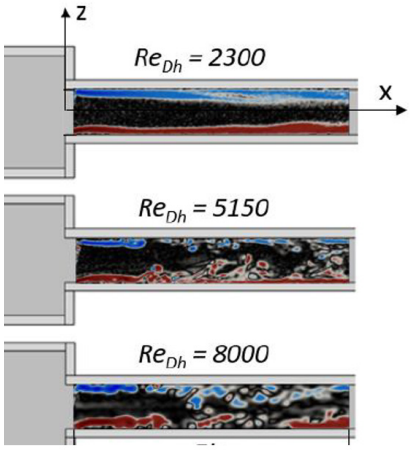
Flow around a swimmer's legs during the dolphin kick.
Courtesy of Friedrich-Schiller-Universität Jena, Institute of Sport Science, Motion Science. Application note: https://www.dantecdynamics.com/notes/piv-measurements-during-the-dolphin-kick-of-a-human-swimmer/

FlexPIV system overview



Overview of the FlexPIV system components, showing the timing and data flow.

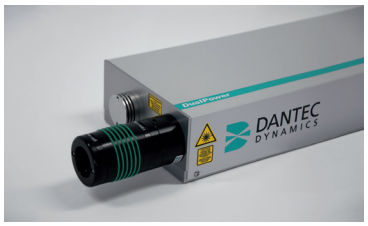
The FlexPIV System is a complete package to start measuring right away. All you need to add is a PC and a seeding system for your flow as well as laser safety equipment depending on your local rules and regulations. See separate data sheets for these components.



Isothermal transition process in wide aspect ratio rectangular channels.
Courtesy of APEX Research B.V., Voorburg, the Netherlands.
Paper: https://www.sciencedirect.com/science/article/abs/pii/S0894177718319903

Laser

The DualPower 65-15 laser is a dual cavity pulsed laser providing 65 mJ pulses at 2 x 15 Hz.
The pulse duration is very short, about 5 ns, which makes it possible to freeze the particle motion even in high velocity flows.
The velocity range is set as a combination of the time between the laser pulses (“delta t”), and the field of view of the camera. With two independent cavities, the delta t can be very short in order to cover high velocities.
Please refer to the data sheet “DualPower lasers for imaging applications” for more information.



DualPower 65-15 laser with the light sheet optics.

Light Sheet optics

Divergence angle 4° or 8°. Can be combined for larger divergence angle.
Adjustable focus distance from 200 to 4000 mm.
Please refer to the data sheet “Light Sheet Optics” for more information.

Cameras and Lens

The FlexPIV System is equipped with the FlowSense GigE 1M-39, a double frame camera with a resolution of 1280 x 960 px (1.3 MP) and a maximum framerate of 39Hz. This matches the repetition rate of the laser well: the laser has two cavities, each running at max. 15 Hz, so the camera’s frame rate must be at least 30 Hz to capture images from all the laser pulses.

The camera uses a CCD sensor, well known for its low noise. Combined with its max. quantum efficiency of >52% @ 530nm, this ensures good image quality even in difficult lighting situations. The 3.75 µm pixels are small enough to help avoiding peak locking but at the same time large enough to gather a higher amount of light for well exposed PIV acquisitions. The minimum interframe time of 1 µs allows for 100 m/s max. velocity even at the smallest field of view.

FlowSense camera GigE.

Synchronizer

The TimingHub ensures that all devices perform their individual tasks at the right time. The device used a USB interface to the PC and is a powerful tool for handling not only the PIV acquisition but also the simultaneous acquisition from other sensors or timing of external devices in the experimental/industrial setup.

The TimingHub is fully integrated into DynamicStudio for easy setup and configuration. All PIV devices are automatically detected, ensuring easy set-up and a short preparation time for the measurement. The connectivity diagram in the software will display the way the synchronization cables are to be connected.

TimingHub

DynamicStudio software

The DynamicStudio software is a key system component linking acquisition, synchronization, data processing and result analysis and visualization together. To calculate the velocity fields from acquired raw images and analyze the results, the DynamicStudio Base package and the PIV add-on are used. Even online visualization of flow fields is possible.

With data acquisition and analysis performed in the same software, there is no need to move data around. Interdisciplinary scientists can get results while in the lab to understand the fluid mechanic part of their task and can focus on data analysis later. Dedicated analysis routines and customized analysis sequences allow for quick investigation and visualization of results. The software is very easy to use and includes extensive data exchange features such as MatLab, Octave, Tecplot and many others.

For further details on the software, please consult separate data sheet on the “DynamicStudio Base package.”

DynamicStudio 2D PIV Add-on

This add-on provides 2D vector field calculations based on state-of-the art analysis methods including Adaptive PIV with multi-grid cross correlation, which adapts to velocity gradients and seeding density variations, and average correlation. Supports deforming windows and high accuracy calculation, proven by the 2014 PIV challenge. Proper Orthogonal Decomposition (POD) allows for investigation of the main spatial modes. Please refer to the data sheet "DynamicStudio Planar PIV Add-on" for more information.

Options

Laser protection eyewear

For the safety of the user, laser protection eyewear as well as laser alignment eyewear is strongly recommended while working with the laser. Please refer to your local Laser safety rules and regulations and the data sheet "Laser Protective Eyewear" for more information.

Seeding

Most flows require the addition of seeding particles for good measurements. For liquid applications, typically tiny particles are mixed into the liquid. Please visit our website for available types of seeding particles. For air applications, either liquid atomization or smoke generators are used to seed the air flow. Please visit our website for available types of seeding generators.

FlexPIV ordering information

9081N0301 FlexPIV System, comprising:

- 2 x 65 mJ 15 Hz Nd:YAG laser with built-in motorized attenuator
- High quality light sheet optics optimized for 532nm
- 1.3 MP (1280 x 960 px) camera
- 35mm f 2.1 C-Mount lens
- Plug and Play GigE interface for the camera
- TimingHub with 8 channels for advanced synchronization
- DynamicStudio imaging software base package
- DynamicStudio PIV add-on

Product overview

System specification	FlexPIV	Comments
Min. Working distance	300 mm	With the included 35mm lens
Min. field of view	37 x 27 mm	@ 300 mm working distance
Max. measureble velocity In double frame mode	100 m/s	@ min. field of view
Max. field of view (Gas)	270 x 200 mm	With DEHS seeding, limited by particle size / laser power
Max. field of view (liquid)	500 x 375 mm	With 50µm PSP seeding, limited by particle size / camera resolution
Working distance for 500 x 370 mm	3.7 m	
Optical Resolution - 37 x 27 mm - 100 x 75 mm - 270 x 200 mm - 500 x 375 mm	 - 0.029 µm/px - 0.078 µm/px - 0.211 µm/px - 0.391 µm/px	The optical resolution is the resolution in µm for one pixel of the camera.
Vector Resolution - 37 x 27 mm - 100 x 75 mm - 270 x 200 mm - 500 x 375 mm	 - 0.925 mm - 2.5 mm - 6.75 mm - 12.5 mm	The vector resolution depends on the size of one interogation area, here assumed to be 32 x 32 pixel. Hence, with a vector every ¼ of the Interogation area, the vector resolution is the smallest slice of resolvable vortices.
Recording time	~ 20 s per 1GB of memory	
Accuracy	Between 90 and 99.99% of the initial displacement in pixels	Depending on the vector displacement
Uncertainty quantification	DynamicStudio comes with different routines to examine the analysis error introduced by PIV seperately for every vector	Results are traceble and one can give a measurement uncertainty according to methods described in literature

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Prager Elektronik
Traunstraße 21, A-2120 Wolkersdorf
T:+43 2245 6725 F:+43 2245 559633
office@prager-elektronik.at
www.prager-elektronik.at

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