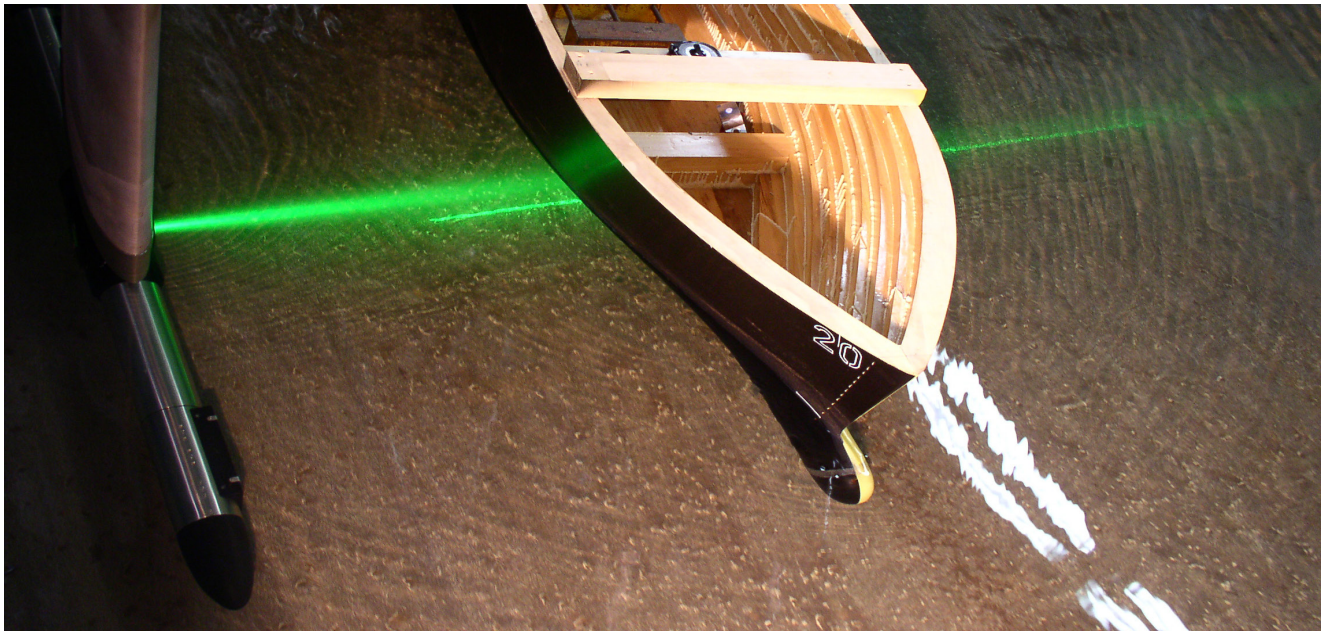
SOLUTION SHEET

Submersible Stereo PIV System

For efficient flow-field measurements in submersed applications



Measurements around a ship model in a towing tank.

Streamlined Submersible PIV system for measurements in towing tanks and other underwater applications

Our well-proven and continuously refined solution for underwater Particle Imaging Velocimetry (PIV) enables efficient flow-field measurements in towing tanks and other applications. The solution is used world-wide for research on hydrodynamic applications such as ship hulls, propellers and offshore constructions.
With a flexible design the system can be reconfigured on-site to enable different measurement setups. The standard two camera StereoPIV (3C2D) system provides measurements of the three velocity components (3C) in a plane (2D). The plane is defined by the overlapping Field-of-View of the two camera/lens modules and a thick laser light sheet.
The system comes with a modular watertight and streamlined probe for minimum flow disturbance. The system is optimized for easy mounting and dismounting, fast calibration and efficient use of the towing tank time.
In combination with traverse and a rigid fixture of the probe, the system can be moved while maintaining alignment and calibration. The entire system - traverse, calibration, automatic measurements and analysis- is operated from dedicated software – DynamicStudio.

Key benefits

- All integrated submersible solution
- 3 velocity component measurements
- Remote controlled laser and cameras
- Streamline shaped to minimize flow disturbance
- Traverse mechanism and rigid mechanics minimizing structural vibrations
- Optimized for space and weight restrictions in towing tank carriages
- Delivered with a trolley for transport and easy storage

The fully integrated Submersible Stereo PIV System

The Submersible Stereo PIV System is optimized for experimental investigations of ship hulls, propellers, offshore constructions and other floating structures performed in towing tanks, wave tanks, and other facilities. The system is customized to meet the needs of the facility and optimized for space and weight restrictions of the towing tank carriages.
The system is a unique product with laser, cameras and support combined into one unit. The system comes with a modular watertight and streamlined probe for minimum flow disturbance. The well-integrated solution assures easy setup and high quality measurements.
The main PIV components are the cameras (camera and mirror modules), the pulsed laser (the light source) and the optics to create a light sheet (light-sheet module). The system is controlled by the DynamicStudio software package. The software is used for setup, control, measurement and analysis. No additional controllers are required.

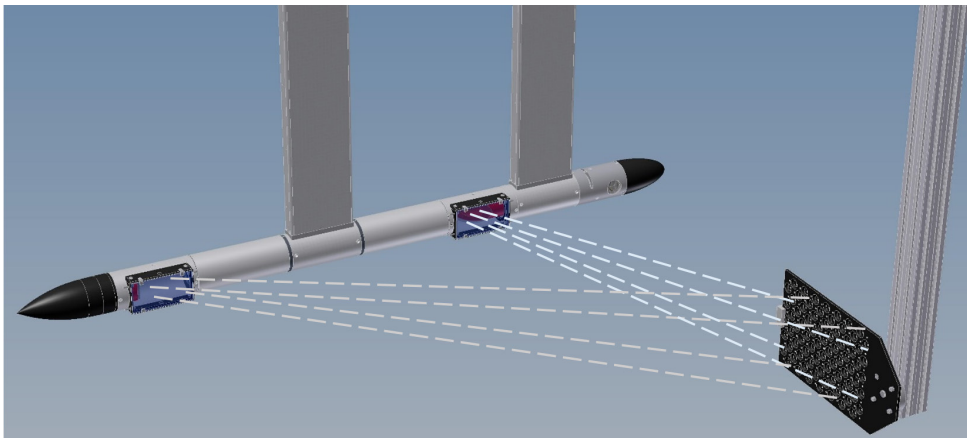


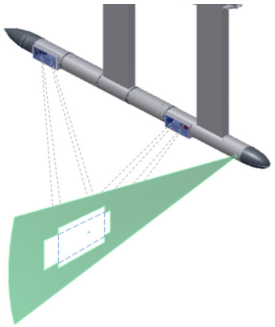
Illustration of the cameras field-of-view in the asymmetrical camera configuration. A dedicated calibration target is used for the camera calibration.

Standard configurations

Dantec Dynamics offers a complete solution for 3 velocity components (3C) measurements in a 2D plane. The cylindrical modular probe consists of two camera modules, two mirror modules and one light-sheet module. To ensure ease of mounting/dismounting with correct orientation, the modules are equipped with guide pins for perfect alignment. The settings of the motorized cameras and the laser are remote controlled.
The camera modules carry the camera, motorized Scheimpflug mounts and the camera lens. The lens is mounted on a compact motorized system, which allows remote controlled focusing and aperture (F-number) adjustment.
The mirror modules, attached to the front of the cameras, enable the cameras to look at the same area on the light sheet. The mirror modules are closed with a window towards the outside water, but are not watertight. By allowing water to fill the mirror compartments, the influence of refraction at the window is minimized. The mirrors are easy to clean or replace if necessary.
The light-sheet module contains light sheet forming optics to deliver an illuminated section matching the FoV (Field of View) of the cameras.

Configuration 1 - Asymmetrical

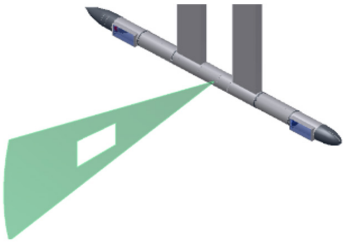
This configuration minimizes the influence of the PIV probe to the flow at the measurement section (light sheet, overlapping FoV) and is ideal for measuring behind a propeller. The viewing angle of the camera close to the light sheet is 22 deg. relative to the light sheet plane. The viewing angle of the camera placed in the back of the probe is 52 deg. relative to the light sheet plane. The mirrors are adjustable for optimizing the field of view.



Asymmetrical configuration. The light sheet (green) and the outlined FoVs from both cameras (white).

Configuration 2 - Symmetrical

With this arrangement, the viewing angles relative to the light sheet plane, are the same for both cameras. The FoVs have the same size of and are easily overlapped. This configuration is suitable if the influence of the PIV probe on the flow at the measurement section (light sheet, overlapping FoV) is negligible. The distance from the probe axis to the center of the imaging area is approx. 1100 mm.



Symmetrical configuration. The light sheet (green) and the overlapping FoVs from both cameras (white).

PIV components

Cameras and lenses

The cameras and lenses are selected to optimize the magnification and field-of-view (FoV) to fit the scope of the measurements. The cameras are positioned at an angle to the light-sheet, Scheimpflug mounts are used to keep the illuminated FoV in focus.

Illumination sources

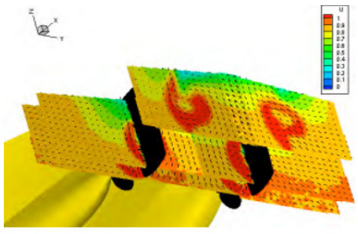
A high energy dual cavity pulsed laser combined with light sheet optics matching the cameras' FoV and the seeding's light scattering properties is included in the system.

Synchronizer

The Synchronizer ensures that all devices perform their individual tasks at the exact right time. The Synchronizer has numerous outputs and inputs for timing of the PIV acquisition as well as the simultaneous acquisition from sensors, control/timing of external devices such as encoders in the measurement application.
The Synchronizer is integrated into the DynamicStudio imaging software platform for easy setup and configuration. All PIV devices are auto-detected, which ensures that the user will not have to enter any specific properties for the system. The connectivity diagram in the software shows how to connect the synchronization cables.

Data Analysis

To calculate the velocity fields from acquired raw images and analyze the results, the DynamicStudio Base package, and add-ons for 2D-2C and 2D-3C analysis are used. Dedicated analysis routines allow for quick user-defined data analysis and visualization of results. Acquisition and analysis are performed in the same software, no need to move data around. The software is very easy to use and includes extensive data exchange features e.g. to MATLAB. For further details, please consult separate data sheet on the "DynamicStudio Software" on our website.



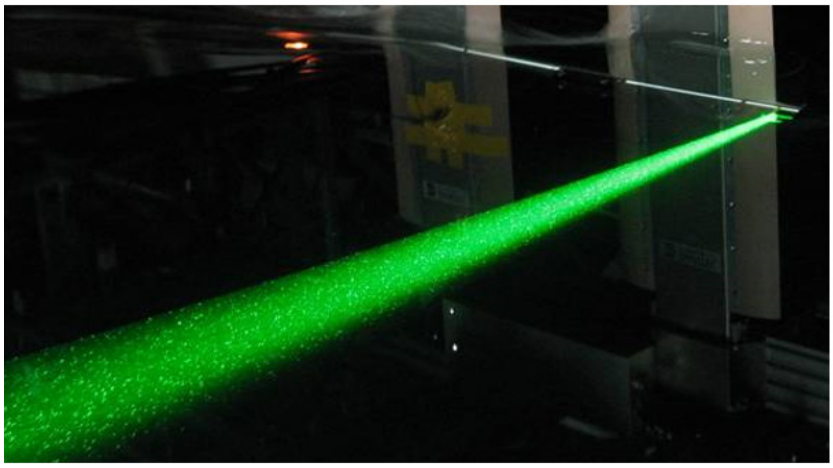
Wake behind a twin-propeller hull. Courtesy of MARIN.

Traversing

An automated traverse system can be provided as an option. The traversing mechanism is controlled from the software so that fully automated experiments are possible. This can be used to map the flow field at different sections around a ship model. The software can construct a complete time averaged 3D-3C flow field by combining 2D-3C data from each measurement section to achieve volume mapping of the flow.

Seeding

The flow needs to be seeded with highly reflective particles e.g. coated plastic spheres. The range of the particle dimensions is typically 20 -200 µm. Polyamide powder with a density of 1,030 kg/m3 and an average diameter of 20-100 µm can be used. The seeding mixture is injected into the flow with the help of local injection rakes.



Symmetrical configuration. The light sheet (green) and the overlapping FoVs from both cameras (white).

Technical specifications of standard design

Specifications for the modular submersible probe with laser and cameras are shown below. Custom modifications to the specifications are available upon request. The standard design allows both Symmetrical and Asymmetrical configurations.
The commissioning process includes mounting, test measurements with the customer and training in the use of the equipment.

Specifications	
Probe Length	2.1 m *
Total Weight	130 kg *
Depth of use	Up to 1 m *
Towing Velocity	Up to 5 m/s **
Measurement Distance	Up to 1.5 m
Field of View	Up to 200 x 200 mm^2 (asymmetrical) Up to 300 x 300 mm^2 (symmetrical)

** Other specifications upon request*

*** Dependent on carriage construction stability and depth of use.*

Order information

Please contact your Dantec Dynamics representative for a detailed discussion of your application.

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