

FlowMaster Underwater PIV System

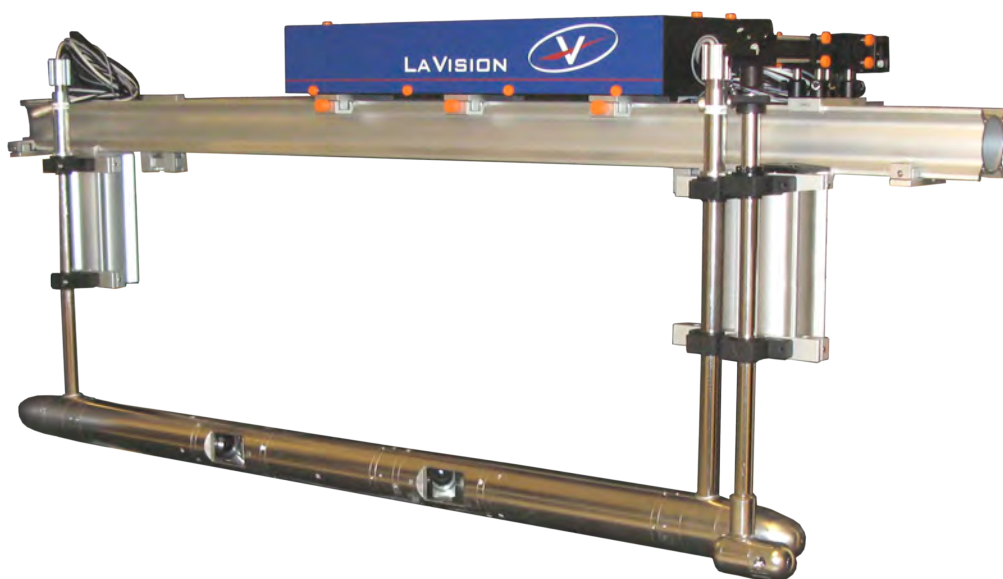
Particle Image Velocimetry
systems for fluid dynamics
measurements under water



*large towing tank facility with
submerged PIV system*

LaVision have been at the forefront of PIV development for over two decades now and a variety of standard and customized **FlowMaster** PIV systems are field-proven worldwide. Our ingenuity is appreciated by the research society as well as by engineers because LaVision solutions give the users not only handy tools but the most universal and variable systems. Our PIV algorithms were successful in the last three events of the 'PIV Challenge' and our 'Self-Calibration' is a patented way to avoid errors due to misalignments.

A modular approach to **FlowMaster Underwater PIV** systems allows a large variety of geometric assemblies with uncompromised optical accuracy. Our compact borescope systems with minimal intrusion under the water keep the electronic equipment above the surface (inquire for details) while the submersible design utilises small high resolution PIV cameras with remote control. Proven mechanic rigidity and minimal dimensions combined with high quality optics and skillful control schemes equip the user with an accurate measurement system just like LaVision customers in other fields like aerodynamics, automotive and turbo machinery are used to.



Applications

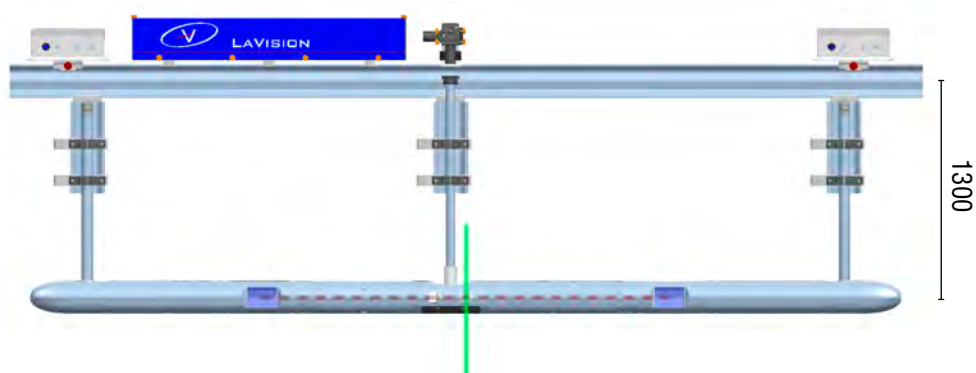
- ▶ general flow mechanics
- ▶ flow resistance minimization
- ▶ design of propellers
- ▶ increase of propulsion efficiency
- ▶ study of cavitation
- ▶ tests of ship manoeuvring

Overview

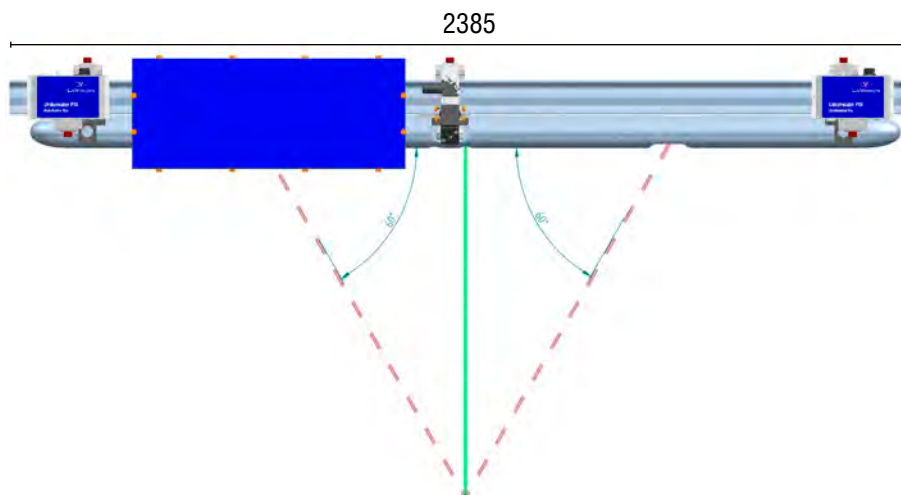
LaVision is offering 4 standard versions of **FlowMaster Underwater PIV** systems

Type	Mount	Camera arrangement	Flow direction
A	horizontal	symmetric	cross flow
B	horizontal	asymmetric	parallel flow
C	horizontal	asymmetric	cross flow
D	vertical	asymmetric	parallel flow

Type A



Side view



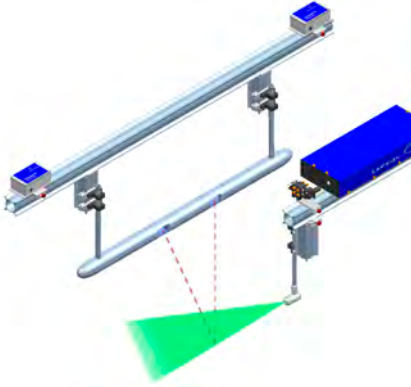
Top view

Field of View (FoV) examples

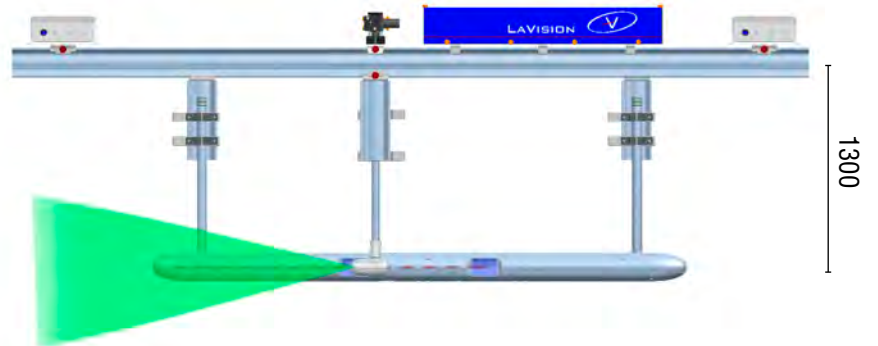
Distance of camera units to center of FoV = 1000 mm

Lens	x-size/ mm	y-size/ mm
28 mm	426	255
50 mm	232	139

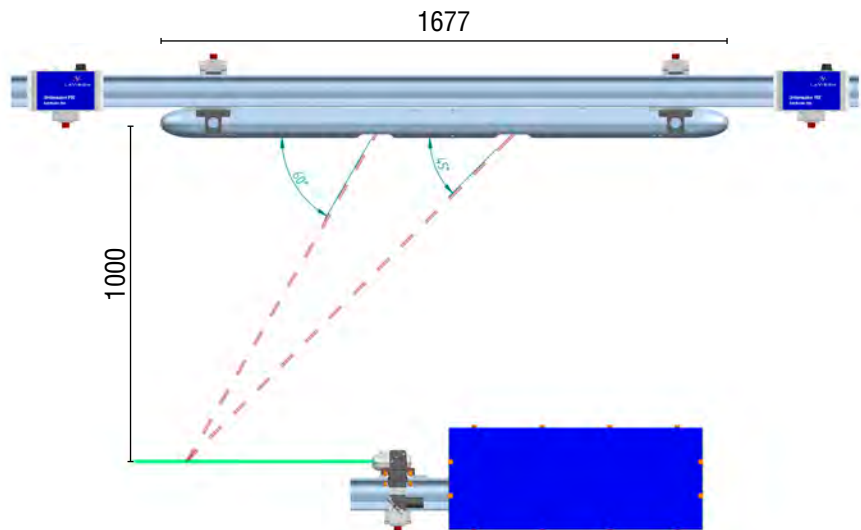
Approximate x/y-size is measured in the center of the common FoV. Due to perspective distortion, the FOV shape is not rectangular and can be smaller at the edges.



Type B



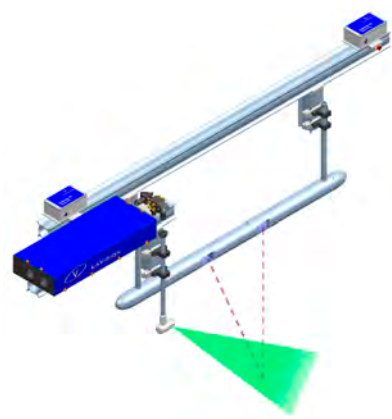
Side view



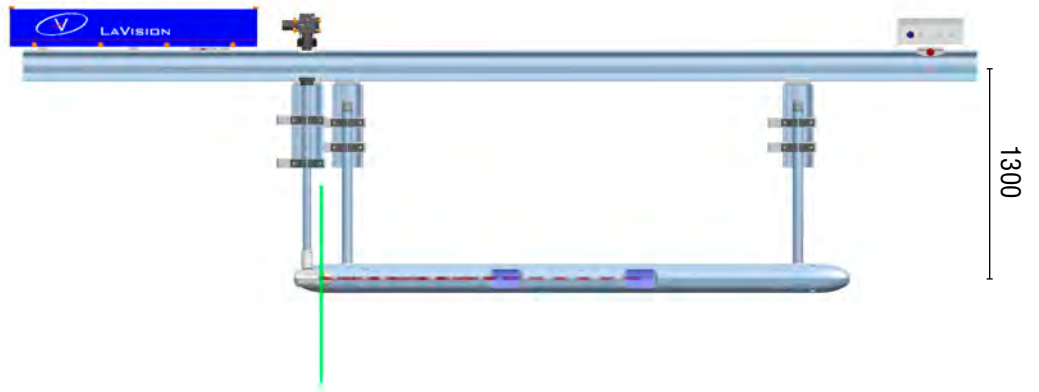
Top view

Field of View (FoV) examples

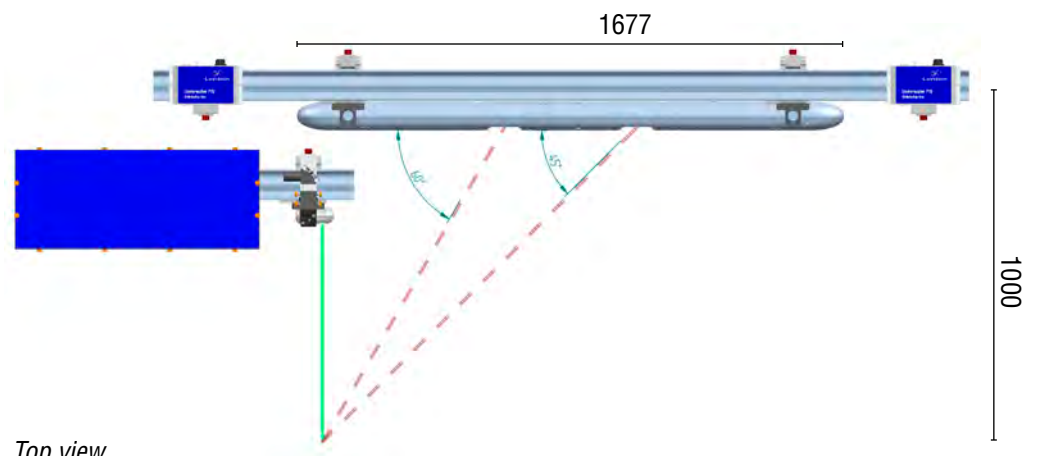
Lens	x-size/ mm	y-size/ mm
28 mm	246	255
50 mm	134	139



Type C



Side view

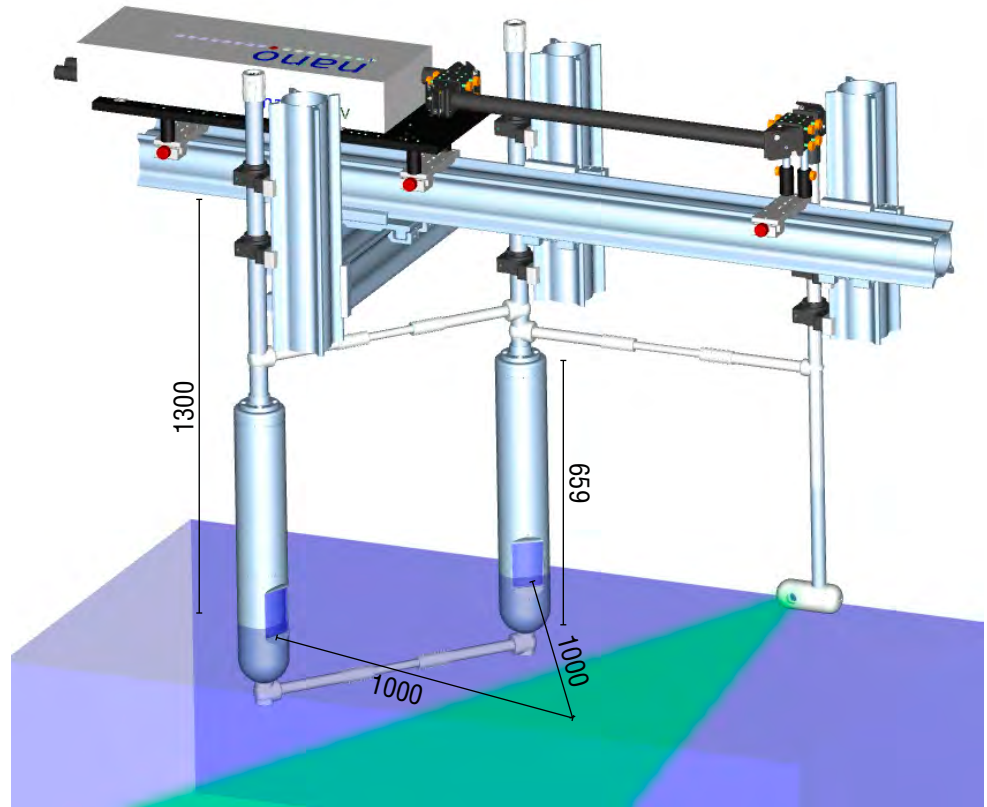


Top view

Field of View (FoV) examples

Lens	x-size/ mm	y-size/ mm
28 mm	426	255
50 mm	232	139

Type D



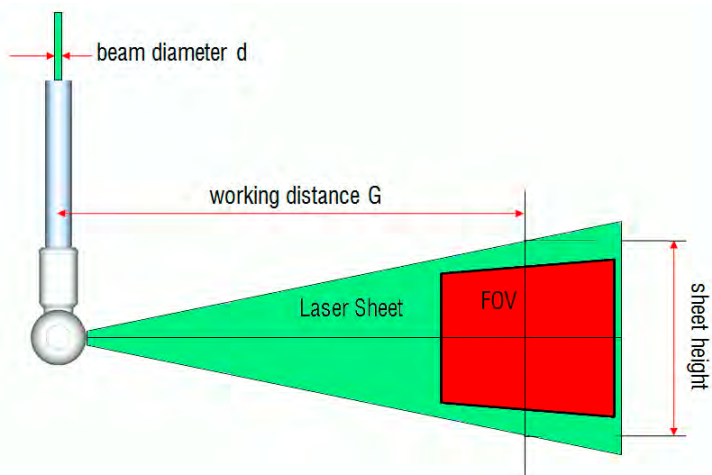
Field of View (FoV) examples

Lens	x-size/ mm *)	y-size/ mm
28 mm	184	220
50 mm	100	119

*) minimum x-size for perpendicular view, becomes larger for oblique viewing angles.

Sheet height table

The laser sheet height depends on the sheet optics working distance (G) and the beam diameter (d). The laser beam diameter can be adjusted using a telescope optics.



Working distance (G)/ mm	Beam diameter (d)										
	2	3	4	5	6	7	8	9	10	11	12
300	24	36	47	59	71	83	95	107	119	131	142
350	28	42	55	69	83	97	111	125	139	152	166
400	32	47	63	79	95	111	127	142	158	174	190
450	36	53	71	89	107	125	142	160	178	196	214
500	40	59	79	99	119	139	158	178	198	218	237
550	44	65	87	109	131	152	174	196	218	239	261
600	47	71	95	119	142	166	190	214	237	261	285
700	55	83	111	139	166	194	222	249	277	305	332
800	63	95	127	158	190	222	253	285	317	348	380
900	71	107	142	178	214	249	285	321	356	392	427
1000	79	119	158	198	237	277	317	356	396	435	475
1100	87	131	174	218	261	305	348	392	435	479	522
1200	95	142	190	237	285	332	380	427	475	522	570
1300	103	154	206	257	309	360	412	463	514	566	617
1400	111	166	222	277	332	388	443	499	554	609	665
1500	119	178	237	297	356	416	475	534	594	653	712
1600	127	190	253	317	380	443	507	570	633	696	760
1750	139	208	277	346	416	485	554	623	693	762	831
1800	142	214	285	356	427	499	570	641	712	784	855
2000	158	237	317	396	475	554	633	712	791	871	950

Camera section for time resolved PIV



System components

1109008 camera section for time resolved PIV
including
Imager MX 4M *), camera lens not included
remote lens controller
remote Scheimpflug controller +/- 10°
Camlink interface, max. length between camera and PC is 5 m, framegrabber included

Diameter 90 mm
Length 310 mm
Weight 3.6 kg
internal threads

Camera section



1109009 camera section
including
Imager pro SX 5M *), camera lens not included
remote lens controller
remote Scheimpflug controller ±10°
Gigabit Ethernet interface, framegrabber not included

Diameter 90 mm
Length 310 mm
Weight 3.7 kg
internal threads

Remote lens



camera lens with motorized focus and aperture
fast and accurate ultrasonic motors

1108621 remote lens f=28 mm
1108620 remote lens f=50 mm
1108622 remote lens f=85 mm

Weight 0.3 kg

Mirror section

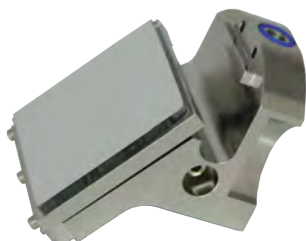


1109004 mirror section
wet or dry operation, empty housing
requires a mirror module

Diameter 90 mm
Length 201 mm
Weight 2.9 kg
external threads on both ends

*) camera is part of the mechanical setup and is not intended to be removed

Mirror modules



60° ± 2° version shown here

Adjustable mirror insert for different view directions
to be placed into the mirror section 1109004

The mirrors can be operated in a water filled mirror section for oblique viewing angles.

Note that the viewing angle is given as the angle seen from the camera position.

backward view

45° ± 2° 1109045

60° ± 2° 1109046

right angle view

90° ± 2° 1109047

forward view

120° ± 2° 1109048

135° ± 2° 1109049

Weight 0.3 kg

Underwater laser sheet optics



1109010 underwater laser sheet optics

including 0° straight direction

and 90° side exit optics , freely rotatable

One 1109024 dual 90° mirror device is included (see below).

Can be used stand-alone or integrated in 1109011 horizontal laser section
in a torpedo assembly.

Sheet divergency full angle: 18° for 8 mm beam diameter, focus adjustment
from above (in-situ).

Diameter 52 mm
Length 117 mm
Weight 2 kg

Support tube diameter 25 mm
Max. laser support tube length 1.3 m

Dual 90° mirror device for laser mount



1109024 dual 90° mirror device for laser mount

Additional mirror setup

allows to position and deflect the laser beam into an appropriate position
before feeding into the laser sheet optics
with clamp for X95 profile

Weight 1.1 kg

Horizontal laser section



1109011 horizontal laser section

incorporates the laser sheet unit into a horizontal setup

This cage setup is needed, when the laser sheet optics 1109010 should be integrated into the horizontal torpedo structure

Diameter	90 mm
Length	210 mm
Weight	1.3 kg
	internal threads on both sides

Horizontal mount



1109015 horizontal mount with support tube

The horizontal mount allows the camera cables to feed into the camera section and to carry the torpedo structure in horizontal configuration.

Diameter	90 mm
Length	58 mm
Weight	2.6 kg
	internal thread on one, external on the other side

Support tube diameter	32 mm
Max. laser support tube length	1.3 m

Horizontal mount with hydrofoils



1109012 horizontal mount with hydrofoils

The horizontal mount allows the camera cables to feed into the camera section and to carry the torpedo structure in horizontal configuration. It can replace the horizontal mount with support tube 1109015.

This enforced mount consists of a rectangular cross section main tube for extra stiffness and a 3 section hydrofoil for reduced drag forces. The sections are of different height (300, 500, 700 mm), so that a different total height can be achieved

Diameter of horizontal mount	90 mm
Length of horizontal mount	134 mm
Length of hydrofoil profile	215 mm

End cap for horizontal setup



1109018 end cap for horizontal setup

The horizontal end cap is needed to close the horizontal torpedo structure at the ends. It is of streamlined shape to reduce drag.

Diameter	90 mm
Length	118 mm
Weight	1.5 kg
	external thread

End cap with window for straight view



1109021 end cap for horizontal setup with straight window

This end cap is mounted directly to a camera section in order to provide a straight view when cameras are used in individual separate torpedos.

Diameter	90 mm
Length	40 mm
Weight	0.7 kg
	external thread

Rotatable watertight tube element



1109028 rotatable watertight tube element

The rotatable watertight tube element allows to freely rotate the tubes connected to it. It is needed to maintain proper orientation of cameras and mirrors with respect to the torpedo structure.

Diameter	90 mm
Length	48 mm
Weight	0.3 kg
	internal thread on one, external on the other side

Hollow tube piece



1109027 hollow tube piece
The horizontal tube is needed to adjust for distance between laser and mirrors for horizontal setups.
minimum length: 32 mm

Diameter	90 mm
Length	variable
Weight	23 kg/ m
	internal thread on both sides

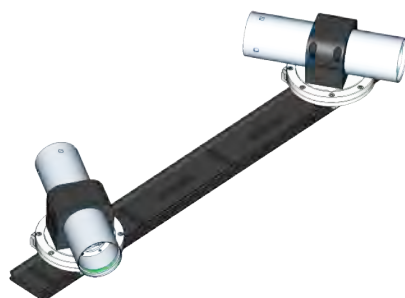
Mount for camera unit
Mount for laser sheet optics



1109025 mount for camera unit
1109026 mount for laser sheet optics
Mounts for support tubes to assemble the system to a carriage based on X95 aluminum profile
sliders for height adjustment

Profile length	750 mm
Weight (total)	6 kg

Camera section
mounting kit



1109042 camera section mounting kit for 2 assembled camera sections, allows installation of underwater cameras on a rail outside the water basin. Consists of 1m X95 rail, clamps and rotation tables for viewing angle adjustment.

Profile length	1000 mm
Weight	approx. 10 kg

Vertical mount



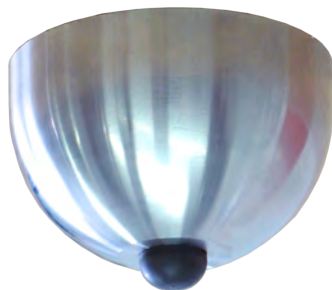
for vertical assemblies only

1109017 vertical mount

The vertical mount allows the camera cables to feed into the camera section and to carry the torpedo structure in vertical configuration.

Diameter	90 mm
Length	50 mm
Weight	2.7 kg
Support tube diameter	32 mm
Max. support tube length	1.3 m external thread

End cap for vertical setup



1109014 end cap for vertical setup

The vertical end cap is needed to close the vertical torpedo at the bottom side. It allows to connect the vertical brace stabilization set 1109016 (see below) at the bottom.

Diameter	90 mm
Length	95 mm
Weight	1 kg internal thread

Brace stabilization set



1109016 brace stabilization set

Brace set for improved stiffness, recommended for vertical setup
set consistion of
2 braces between camera sections and laser
1 brace between both camera sections

Diameter	25 mm
Weight	2 kg/ 1 m length

Electronics circuit box



1109032 electronics circuit boxes
including:
in one housing
„Mains Box“
water leakage sensor circuitry
power supplies
voltage: 80-260 VAC, 300 Watts
USB connection to PC (5 m)
cable length to distribution box: 13 m

Dimensions (W x H x D) 440 x 480 x 270 mm
Weight 15 kg

„Distribution Boxes“
In two separate housings (one for each camera)
control electronics for camera, remote focus and remote Scheimpflug

Cable length to „Mains Box“ 13 m
Weight 2 kg

Joints

The tube parts are connected through standard threaded joints with sealing.
Threads are internal (int.) or external (ext.). Adapters are available to change the thread.

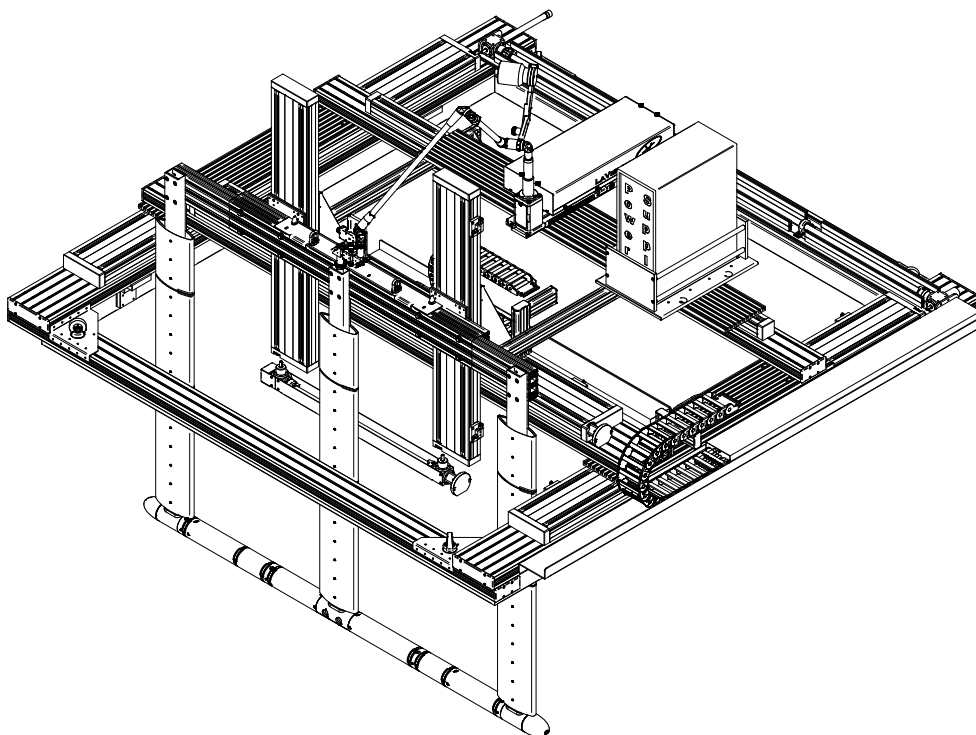


internal thread
The thread is on the inside of the tube



external thread
The thread is on the outside of the tube.
An o-ring provides the sealing

Optional motorized 3D-translation stage

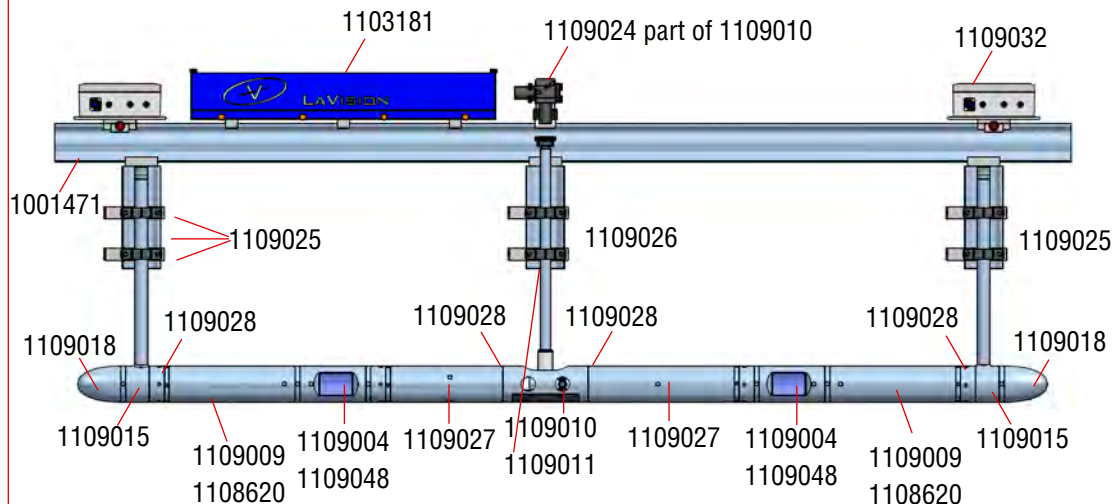


A traversing system can be prepared as a 1D- or 2D- or 3D-unit with a maximum length of 2500 mm per axis. Due to the weight of the system each axis is made up of 2 drive units of which one is actively driven and the other is passively driven (forcedly connected to first unit). The actual usable traversing range is decided by the geometric assembly of the underwater PIV system. It is maximized with a vertical assembly where all 3 mount rods are closest to each other. It is the minimum with the linear symmetric torpedo assembly. Positioning is fully controlled by DaVis software at an accuracy of < 0.1 mm. Coupling of the laser beam to the driven PIV system is done with a flexible beam guiding arm.



*LaVision's stereoscopic 3D
underwater PIV system at the
Franzius Institute Hannover*

Example setup



Mechanics consisting of

Pieces	Part number	Description
2	1109009	Camera sections /w camera Imager pro SX 5M and focus ring and remote Scheimpflug
2	1108620	Remote lens f=50 mm
2	1109004	Mirror section, empty housing
2	1109048	Mirror for 120° view direction, insert
1	1109010	Laser sheet optics with 90° mirror unit
1	1109011	Horizontal laser sheet section
2	1109015	Horizontal mount
2	1109018	End cap
2	1109025	Mount for camera
1	1109026	Mount for laser
1	1109032	Electronic circuit box incl. cables and 2 distribution boxes
2	1109027	Hollow tube
4	1109028	Rotatable tube
1	1103181	Laser (beam diameter d = 6.35 mm)
1	1001471	Profile-X95 , l=2500 mm
not shown here : control PC with DaVis software and synchroniser electronics (1108057) and interface board (1108215); 3D calibration plate ; seeding particles		

Ordering Information

Part number	Description
1109008	Camera section for time resolved PIV /w camera Imager MX 4M and focus ring and remote Scheimpflug, Camlink interface, max. length between camera and PC is 5 m, framegrabber included
1109009	Camera sections /w camera Imager pro SX 5 M and focus ring and remote Scheimpflug, Gigabit Ethernet interface, framegrabber (# 1108215) needs to be ordered separately
1108215	Gigabit Ethernet card (required in combination with 1109009)
1108621	Remote lens f=28 mm
1108620	Remote lens f=50 mm
1108622	Remote lens f=85 mm
1109004	Mirror section
1109045	Mirror module for 45°
1109046	Mirror module for 60°
1109047	Mirror module for 90°
1109048	Mirror module for 120°
1109049	Mirror module for 135°
1109010	Underwater laser sheet optics
1109024	90° mirror device for laser mount
1109011	Horizontal laser section
1109015	Horizontal mount with support tube
1109012	Horizontal mount with hydrofoils
1109018	End cap for horizontal setup
1109021	End cap with window for straight view
1109028	Rotatable watertight tube element
1109027	Hollow tube piece
1109025	Mount for camera unit
1109026	Mount for laser sheet optics
1109042	Camera section mounting kit
1109032	Electronic circuit box incl. cables and 2 distribution boxes
1109017	Vertical mount
1109014	End cap for vertical setup
1109016	Brace stabilization set
1109022	Tube adapter internal thread to connect 2 external threads to each other
1109023	Tube adapter external thread to connect 2 internal threads to each other

Optical items for vertical
assemblies only

Accessories

Data provided by LaVision is believed to be true.
However, no responsibility is assumed for
possible inaccuracies or omissions. All data are subject
to change without notice

May-14

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