

Manual FLOWlab educational PIV system (EduPIV)

General remarks

The OPTOLUTION FLOWlab is a small circulating water tunnel for education. It is bundled with a 500 mW (Laser class 2M) pulsed laser with synchronizer and sheet optics, and the OPTOcam 2/80 (160 fps, 2 megapixels, USB 3.0) with suitable band pass filter. These components offer unparalleled PIV performance in a cost-effective eduPIV package. Inside the water tunnel, a powerful thruster generates a velocity up to 0.4 m/s. Several flow straighteners rectify the flow in the test section measuring 140 x 125 x 200 mm. Three example flow bodies are supplied that can be examined by the students. OPTOLUTION also provides scripts for practical courses that involve the analysis of the vortex shedding frequency of cylinders, the circulation (lift) of flat and cambered wings, and more common tasks dealing with PIV in general.

This manual deals with the setup of the water tunnel. To learn how to setup the camera and the laser, please read the instructions of these devices.

Caution

Please keep the electronic components (laser, camera, motor controller, power supplies) dry.

Hardware setup

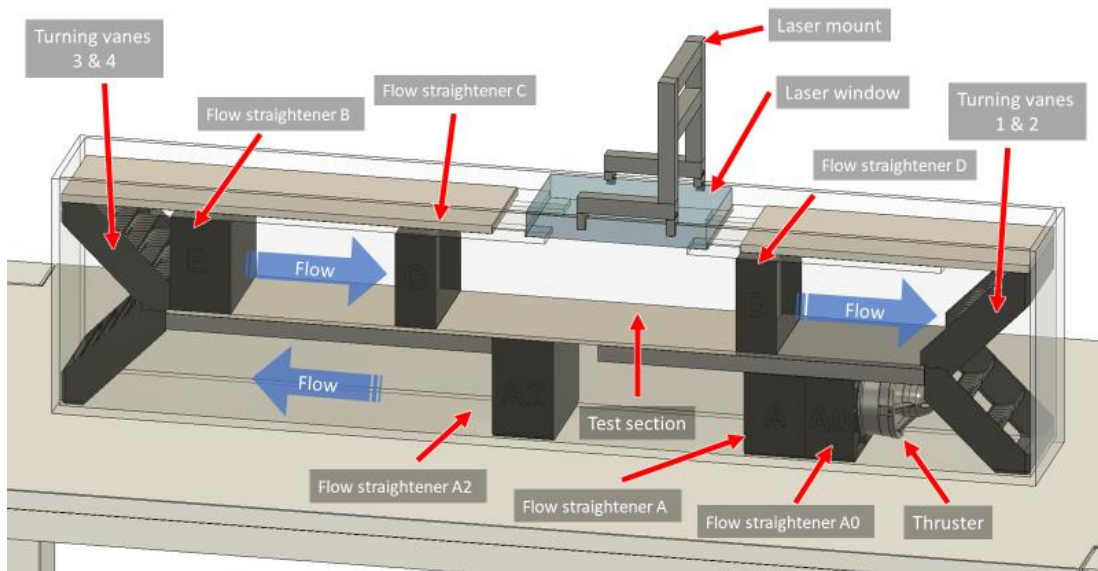


Figure 1: FLOWlab overview



Figure 2: The motor controller

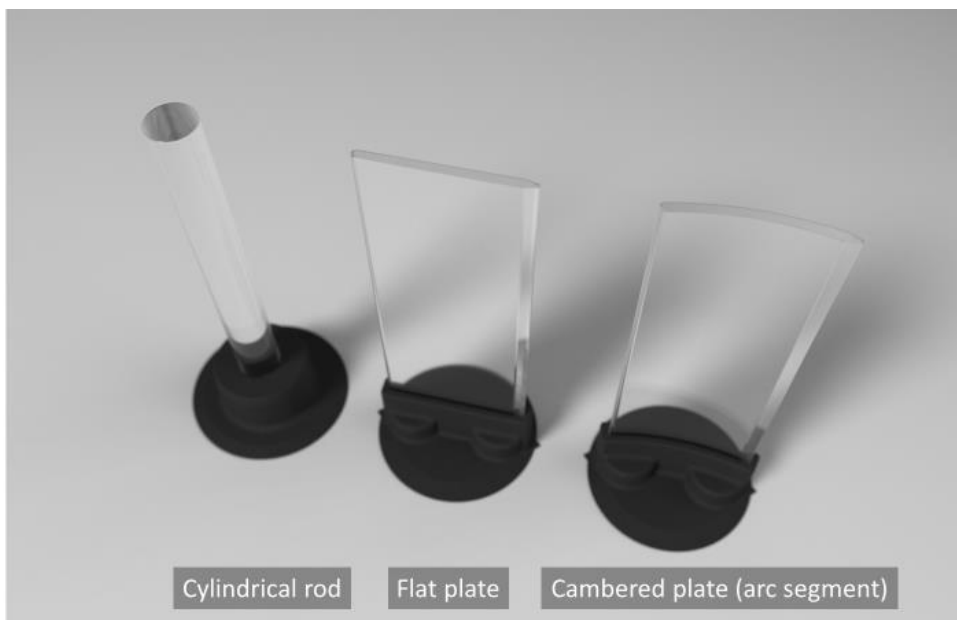


Figure 3: Transparent flow bodies. Cylinder: $Re\ 0 - 6'000$, wings: $Re\ 0 - 20'000$

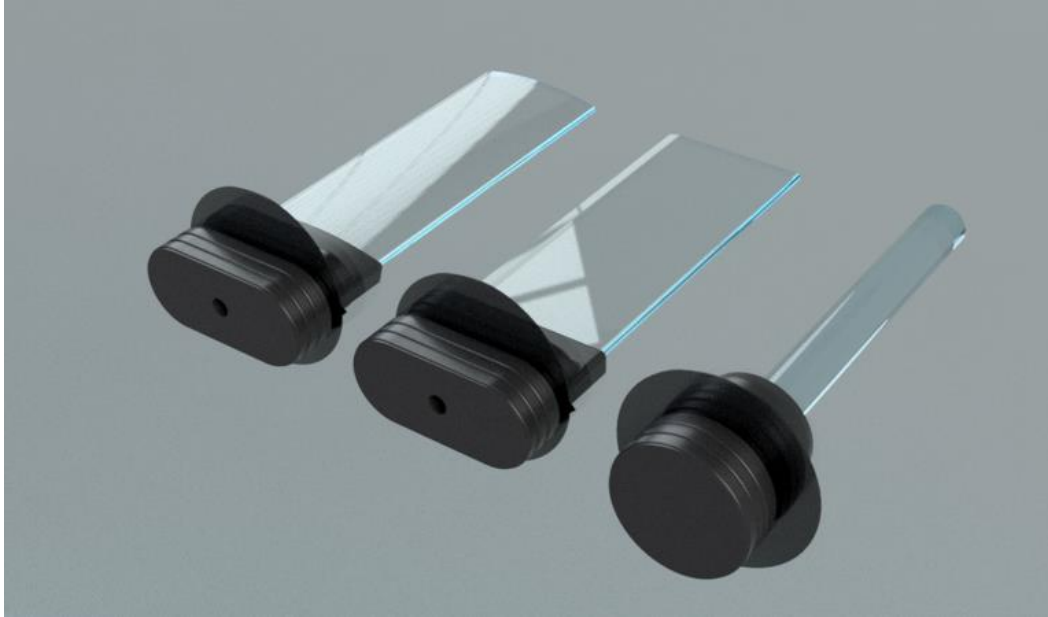


Figure 4: Magnets at the outside of the aquarium hold the flow bodies in place

Install all the flow straighteners and covers (except for the laser window) before you fill in water. Follow the sequence shown in this video:

<https://youtu.be/NgWP6TtOhXw>

Make sure you install the turning vanes in the right orientation.

Add water until it is rising just above the top covers, but not above the laser window. Fresh tap water usually contains a lot of gas that creates small bubbles on all surfaces in the aquarium. It takes approximately a day until these bubbles have disappeared on their own. We recommend to pause for a day after fresh water has been added and before adding the particles.

Add one level teaspoon of polyamide particles to a small vial or bottle, add some water and shake the bottle until no particles stick together anymore. Then pour this suspension into the aquarium. Install the laser window and let the thruster run at full throttle for a minute to distribute the particles.

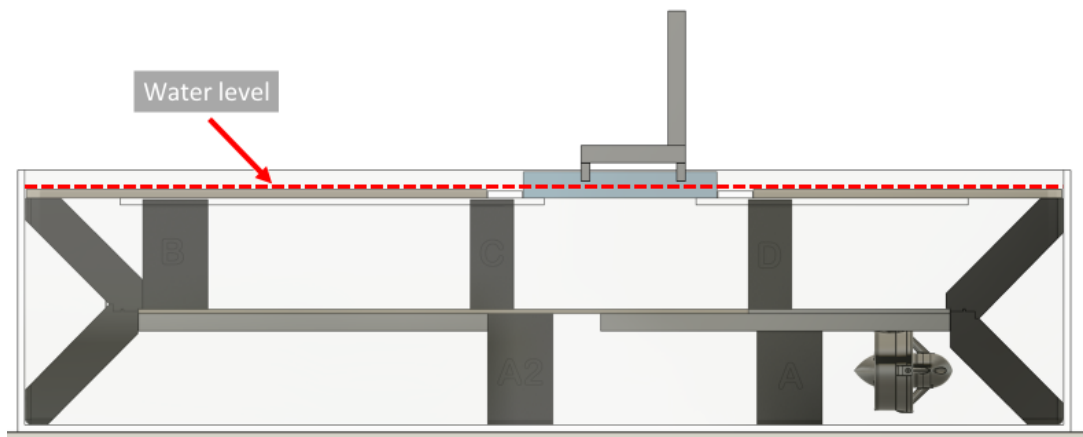


Figure 5: Water level recommendation

Performing experiments

Install the laser on the laser mount and make sure it is aligned perpendicular to the laser window (assure that the reflection from the laser window hits the laser in the middle of the lens). If necessary, focus the laser sheet by moving the middle lens element of the laser. Put the camera on the tripod and centre the measurement section. Connect the synchronizer and interlock cables as shown in the manual of the laser. Always make sure that there are no water drops on the windows of the aquarium. Good starting values for measurements at 0.4 m/s are: 1000 μ s pulse separation, 100 % laser energy, camera gain = 10.

Insert one of the flow bodies and hold them in place by adding the corresponding magnet outside of the aquarium.

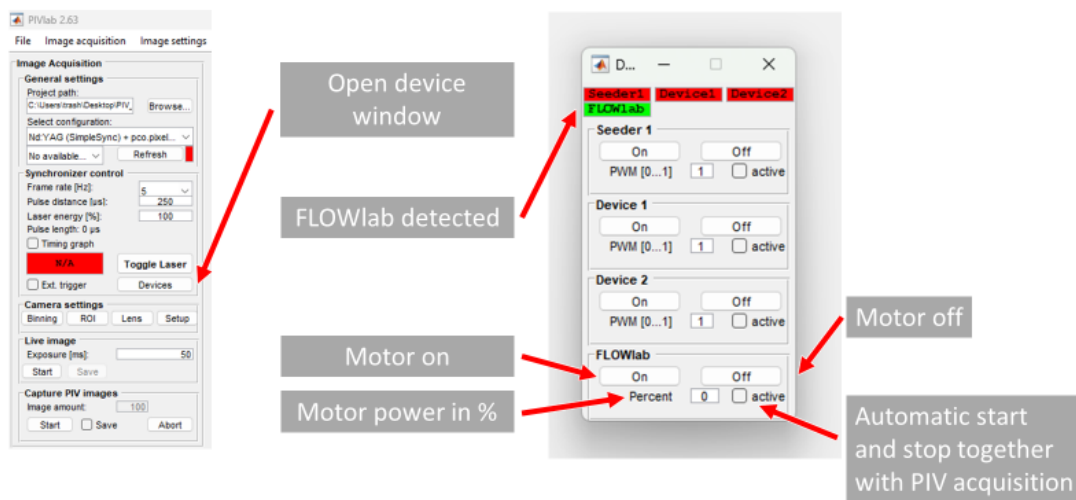


Figure 6: Control of FLOWlab motor speed from PIVlab

To perform an experiment, follow the steps shown in this tutorial video:

<https://youtu.be/8IQSODoYUr0>

Maintenance

FLOWlab uses 50 μ m polyamide particles for seeding the flow. These particles tend to stick to surfaces. Particles that stick to the glass of the aquarium should be removed with a brush regularly. Change the water from time to time and also add some chlorine to prevent the growth of microorganisms. Flow straighteners, turning vanes and the laser window must be cleaned with great care to avoid damage or scratches. The aquarium can best be cleaned with a soft brush after removing the water and all the inserts.

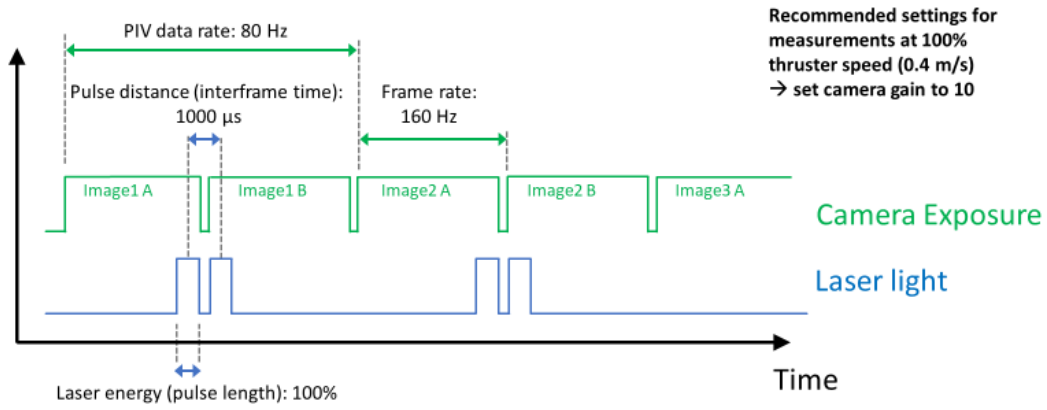


Figure 7: Recommended PIV settings for measurements at 0.4 m/s. A pulse distance of 1000 μs will yield a displacement of approximately 4 pixels when the full test section (200 mm length) is captured.