

HM 132

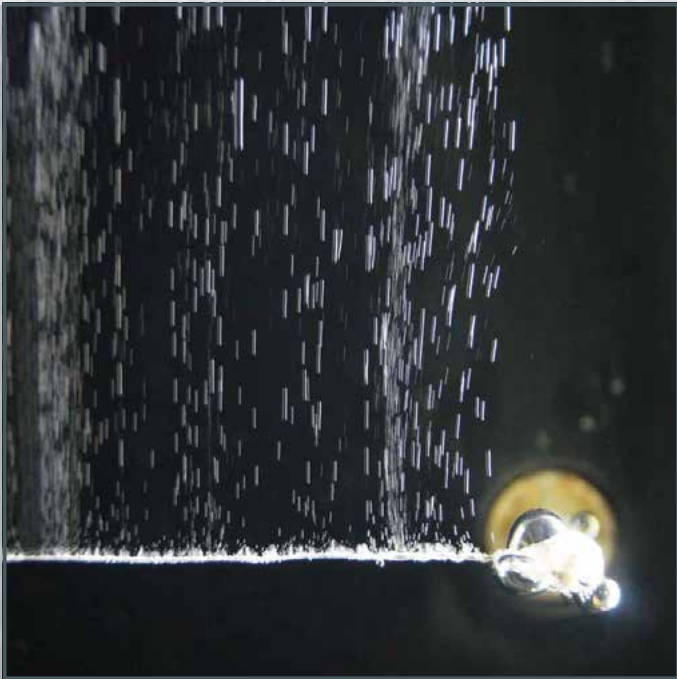
Vertical visualisation of flow fields



Movement detection

Flows can be visualized by floating particles or gas bubbles. These particles or gas bubbles must be so small that they follow the flow without distortion.

For good visualisation of the flow fields it is important to have a good contrast between the fluid and the particles or gas bubbles. As gas bubbles reflect the light well owing to their spherical shape this allows for an excellent contrast.



Electrolytically produced hydrogen bubbles as contrast medium.



Optional accessory: high-sensitivity camera

Real – Digital – Brilliant

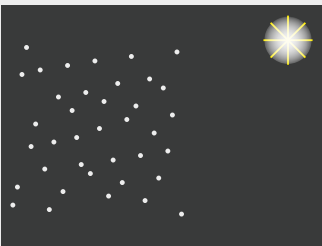
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Vertical visualisation of flow fields

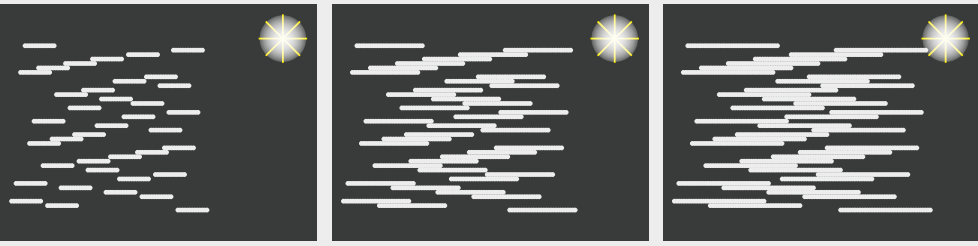
Working with exposure times t_E

There are various possibilities for detecting a movement process. Exposure time controls the duration of a recording. The intensity and duration of the exposure determines how the movement processes in the photograph are displayed.

Short t_E : Standing image

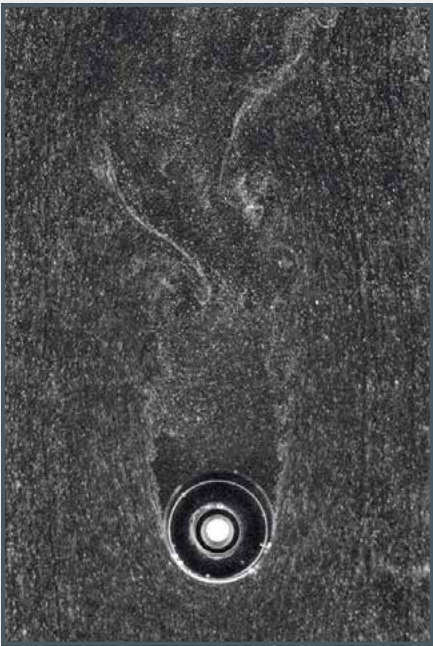


Long t_E : Motion blur occurs



Exposure time t_E variable. Lighting constant.

$v = 7 \text{ cm/s}$



$t_E = 1/200 \text{ s}$

Snapshot with single bubbles



$t_E = 1/5 \text{ s}$

Clarification of vortex structures



$t_E = 1/1 \text{ s}$

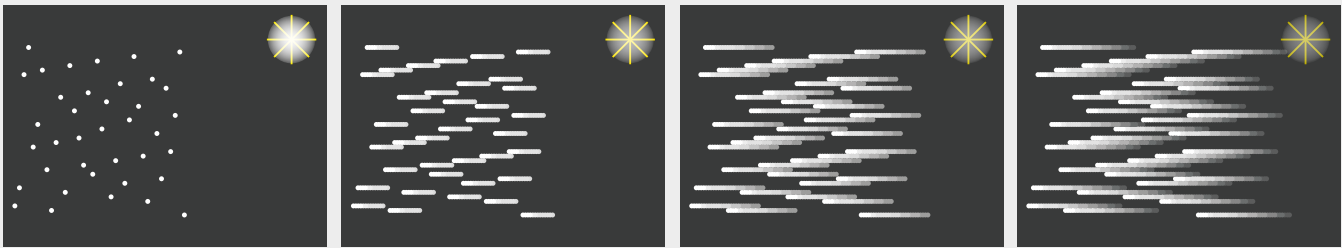
Visualization of the affected area

With a camera with adjustable exposure time t_E , the flow state can be kept as an image in a simple manner. Individual bubbles can smear to lines. If the lines are still clearly separated, the

velocity of the bubbles can be calculated by reproduction scale, length/width of lines, and exposure time.

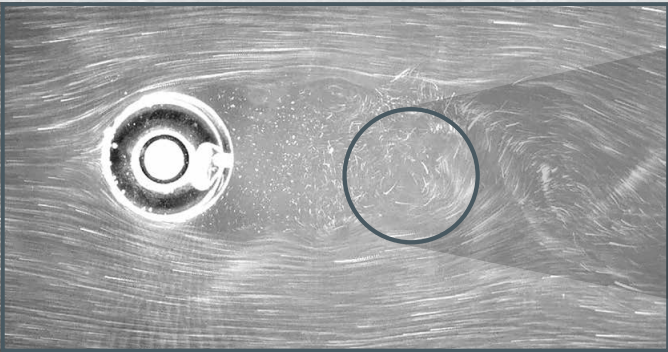
Particle Tracking Velocimetry – PTV

Motion blur gets directional information by decreasing illumination intensity

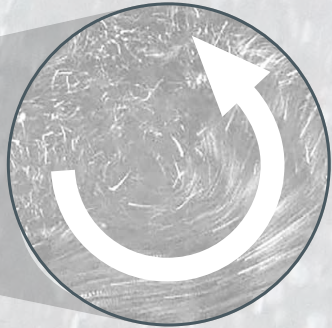


Exposure time t_E variabel. Lighting dimming.

By dimming the illumination within the exposure time, the bubbles produce lines in the image. The fading of the lines shows the flow direction. The length of the lines is proportional to the velocity.

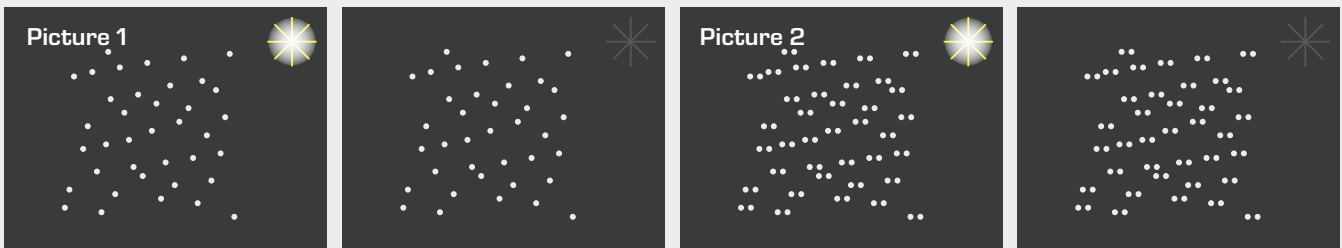


$v = 7 \text{ cm/s}$



Particle Image Velocimetry – PIV

Double image. Usually applied in two image files.



Exposure time t_E short, double. Lighting short, intense.

Software compares two images taken one after the other, quickly. The direction of motion and magnitude of the bubble patterns are calculated. With the reproduction scale and the time offset between the images, the speed can be determined.

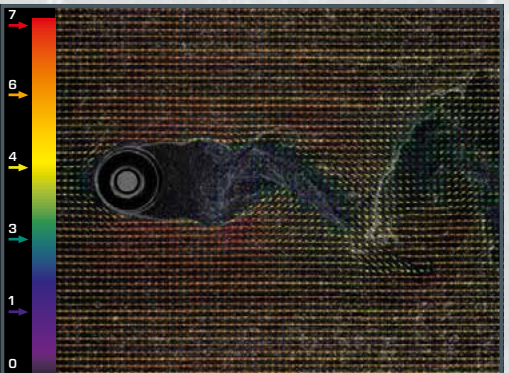


Image created with ImageJ, PIV

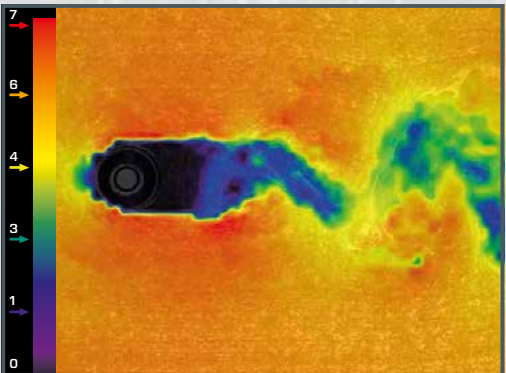


Image created with ImageJ, PIV