Laser Doppler Anemometer (CA-1350)

Laser Doppler Anemometry is a contactless technique for the measurement of velocities. Its principle is based on the phenomenon of the Doppler frequency shift of (Laser) light scattered by moving particles. This frequency shift is directly related to the velocity of the particles, and hence the Laser Doppler Anemometry is an absolute measurement technique which does not require any calibration. Technical applications of a Laser Doppler Anemometer (LDA) are the measurement of flow rates for example in wind tunnels or the velocity control of moving surfaces like in paper manufacture.

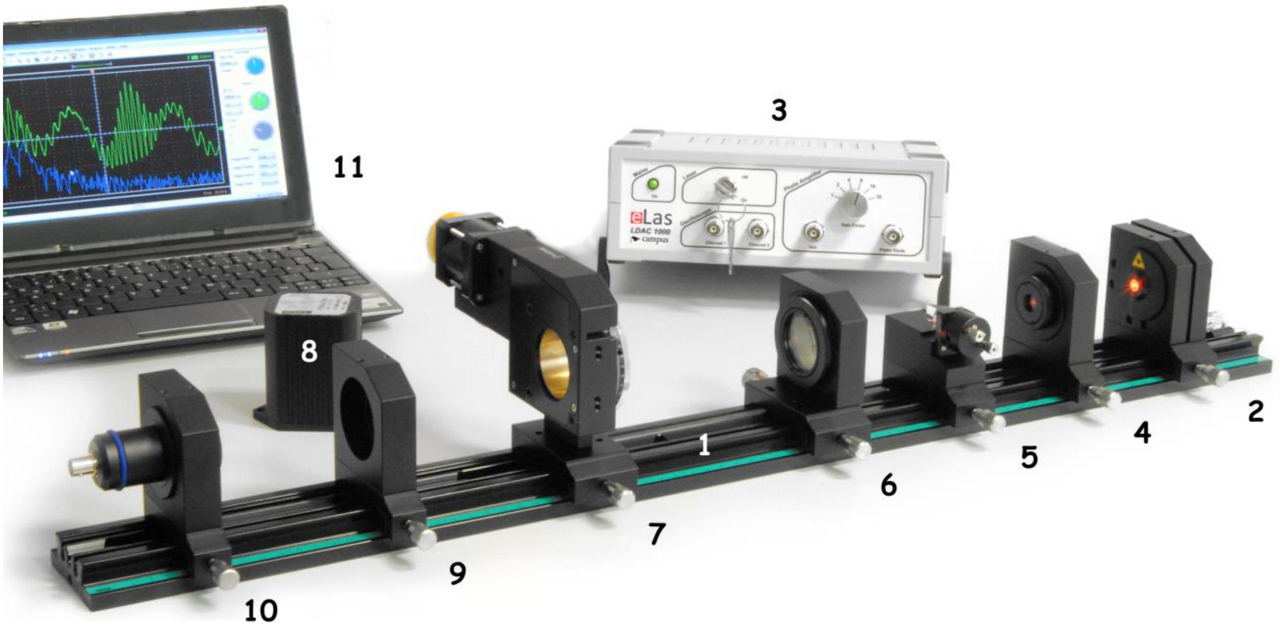
The aim of this experimental kit is to demonstrate the working principle of an LDA. Two coherent laser beams cross at the measuring spot at which a rotating acrylic disc with small distortions is placed. Distortions passing the beams' cross point generate scattered light. The frequency of this scattered light is up- and downward Doppler shifted causing a low-frequency signal beating. This beating is proportional to the velocity of the distortions in the measuring spot. Scattered light is collected by a lens and focused onto a photo detector. By fast Fourier transformation the frequency is extracted and the velocity of the particles can be deduced. This velocity is compared to the rotation velocity of the disc at the rotation stage. Further, the influence of different intersection angles on the Doppler signal will be tested.

For signal capture and analysis a USB oscilloscope is integrated in the LDA controller unit.

Educational Objectives of Investigation

- Doppler Shift
- Beam Interference
- Scattering of Light
- Velocimetry
- Fourier Transformation
- Particle Size

Setup and Components



1 Flat rail 800 mm with scale
2 Diode Laser in θ/φ adjustment holder on carrier
3 Laser supply and signal controller with integrated USB scope LDAC 1000
4 Variable beam attenuator filter in holder on carrier
5 Beam splitter and steering optics on carrier
6 Focusing lens in holder on pinion-drive carrier
7 Motorized rotation stage with acrylic scattering discs on carrier
8 Rotation controller
9 Collimating lens in holder on carrier
10 Photo detector in holder and aperture on carrier
11 Netbook for data acquisition
12 Non-reflective caliper
13 2 BNC cables (not shown)
14 Set of interconnection cables (not shown)
15 User manual (not shown)

Ordering Information

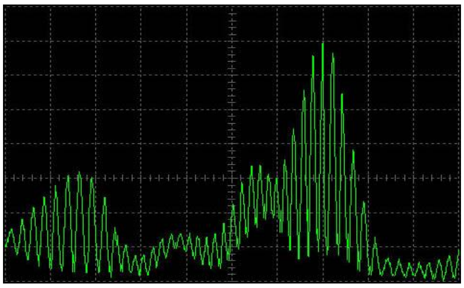
For ordering the Laser Doppler Anemometer experimental kit (CA-1350) use ordering number: 490091350

www.e-las.com contact@e-las.com Phone +49 761 2172 4873

Measurements and Handling

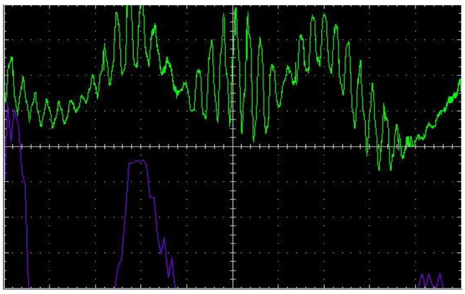
Some of the possible measurements are presented in the following list:

- **LDA signal detection**



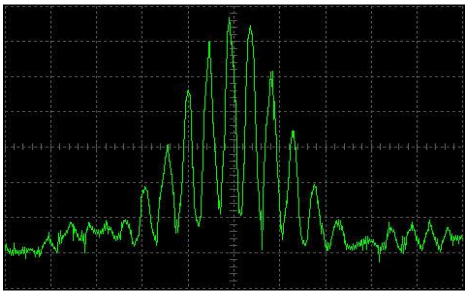
With a frosted disc installed in the rotation stage the detection of permanent LDA signal oscillations are possible, provided the optical system is properly aligned. A signal with quite good signal to noise ratio may look like shown in the scan. Goal is to align the system for a signal with modulation contrast as high as possible.

- **Determination of the Doppler frequency**



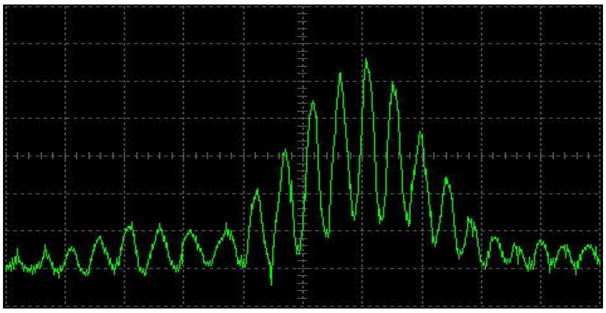
However, even in case of worse signals the LDA beating frequency can be determined either by measuring the temporal fringe spacing or by the Fast Fourier Transform function of the oscilloscope, as shown in the picture.

- **Single LDA burst detection**

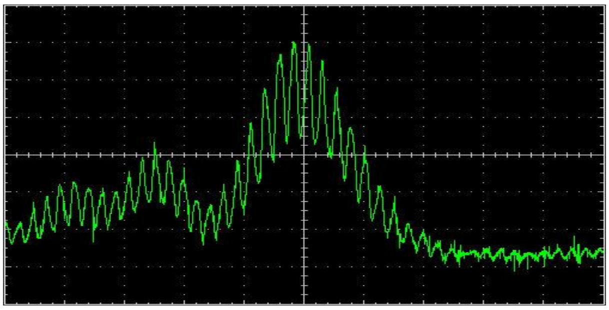


When exchanging the frosted disc for a disc with fine radial scratches single LDA bursts can be generated and detected. In the scan shown aside the LDA signal of a single distortion shows almost maximum modulation depth. For such a high contrast a fine adjustment of the focusing optics has to be performed. The signal is taken in the DC mode of the oscilloscope, the 0 V line is on the bottom of the graph.

- **Influence of the lens focal length**



Since the system comes with two focusing lenses of different focal lengths, all measurements can be performed using one or the other focal length. Two bursts are presented here as an example of the influence of different lenses at the same rotation velocity. The left scan is recorded using a f = 150 mm lens, whereas the right scan uses a f = 80 mm lens. An increase of the LDA frequency and a decrease of the burst’s width for the shorter focal length can be seen clearly.



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