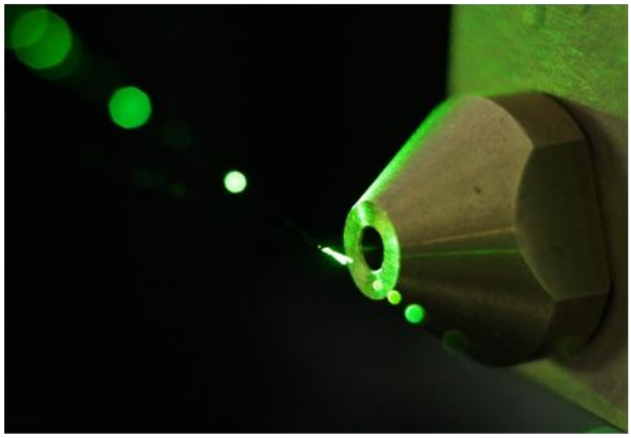
LDV-Profile Sensor



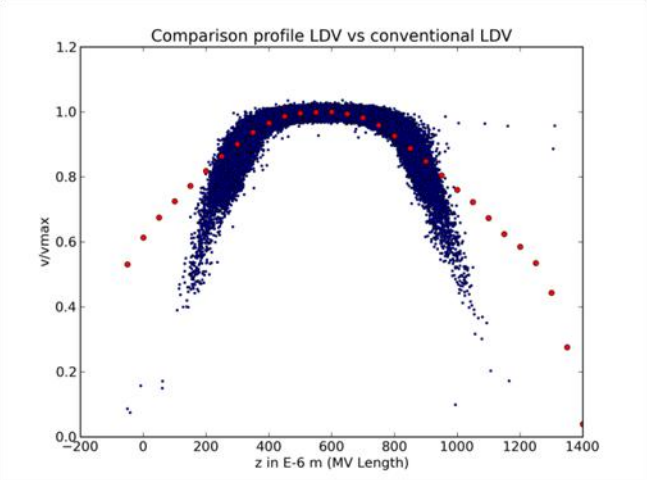


Fig 1: Velocity distribution in a free jet measured with **blue**: Profile Sensor, **red**: conventional LDV

Benefits:

- Very high local resolution of velocity measurements (e.g. 10µm)
- Compact and flexible modular design
- commercial world first

Overview

Using conventional LDV systems in strong velocity gradients is difficult, because the measured velocity is an average over the length of the measuring volume. Even the use of front lenses with short focal length and measuring volumes of less than 1 mm is not a solution because the spatial resolution required for measurements in boundary layers is about 1-10 µm. ILA GmbH and OPTOLUTION Messtechnik GmbH developed in cooperation with the Technical University of Dresden a new LDV-profile sensor that offers a spatial resolution of 1 % of the length of the measurement volume.

The LDV-profile sensor probe contains two Nd:Yag-Laser (532 nm and 561 nm), works with the normal 2D-LDV controller and with an extension of the proven LDV software Qt-LDA. Fig. 1 shows the comparison of the measurement results inside a free jet of a conventional LDV (red dots) and a LDV-profile sensor (small blue dots). The free jet has a diameter of 1 mm. The length of the measurement volume of the conventional LDV (f=160mm) is about 500 µm.

The LDV profile sensor offers a length of the measuring volume of 1 mm with a spatial resolution of 1% (10 µm). It is obvious that the conventional LDV is not able to resolve the high velocity gradient in the shear stress region of the free jet.

The basic idea of the developed LDV-profile sensor is to detect the position of the particle inside the measuring volume. This is realized by the overlap of two measuring volumes with different wavelength, one with a divergent fringe system the other with a convergent one. The ratio of the detected Doppler frequency of both fringe systems f_{D1}/f_{D2} is used to calculate the particle position z inside the measuring volume. The velocity can be calculated with the known fringe distance under consideration of the deviation of the fringe distances.

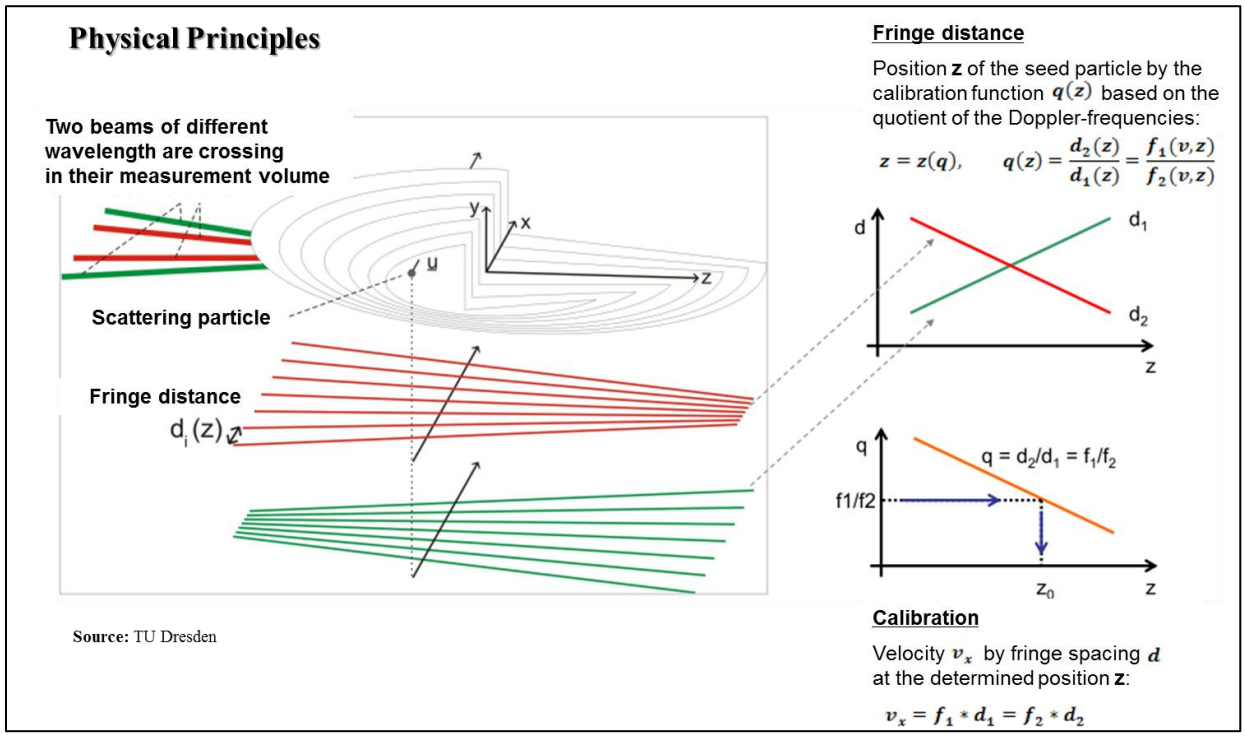


Fig 2: Measuring Principle of Profile Sensor

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Specifications

Weight 5.5 kg
Focal length: 160 mm, 250 mm
Length of measuring volume: 0.5 mm, 1 mm
Dimensions: 80 x 115 x 420 mm

Laser Power: 75, 100, 200 mW
Wavelength: 532 nm, 561 nm
Spatial resolution: 1% of MV length
Controller: 2D-LDV standard controller

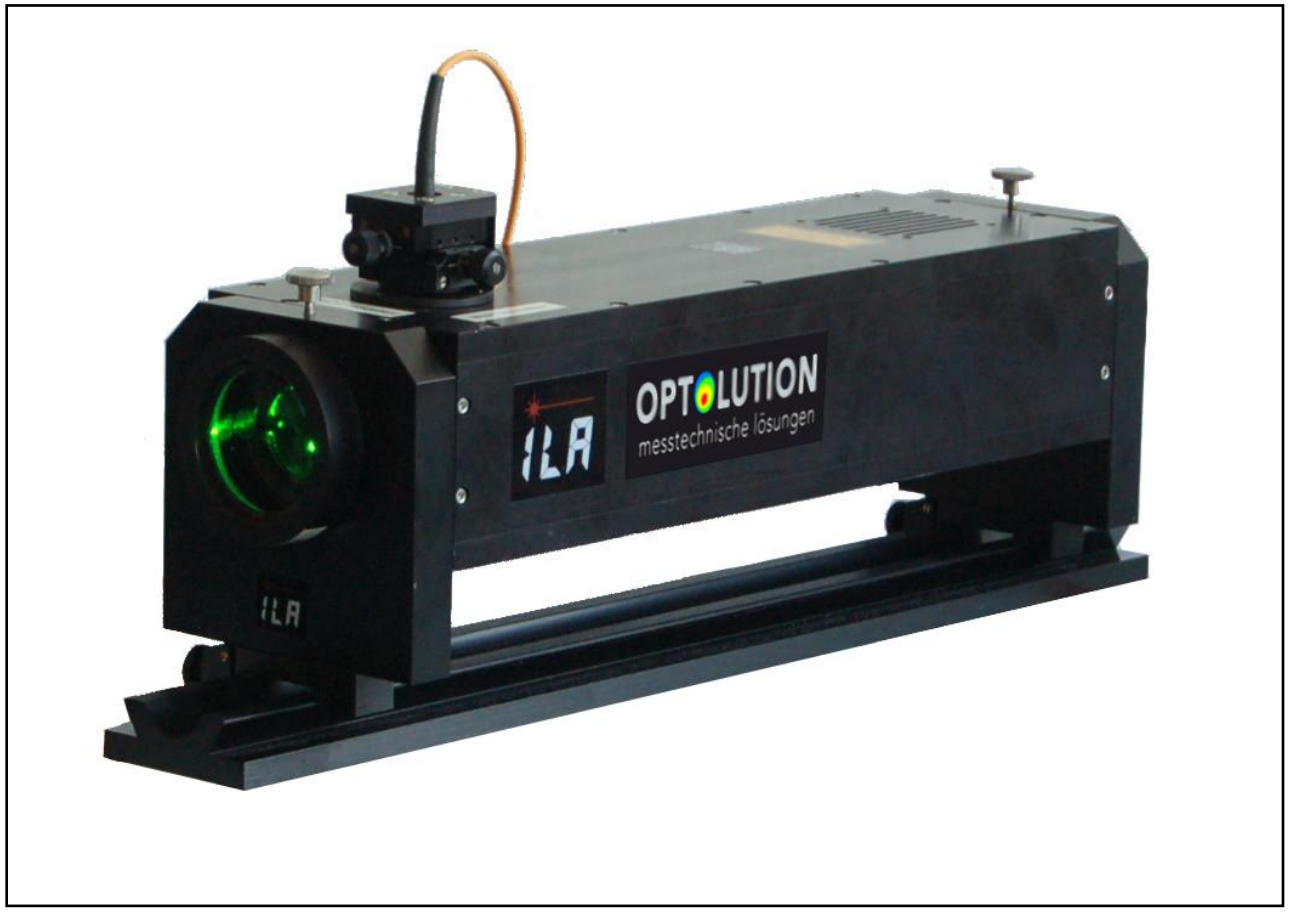

Fig 3: Profile Sensor probe

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Application on a microchannel-testflow (pipe diameter = 0.4 mm)

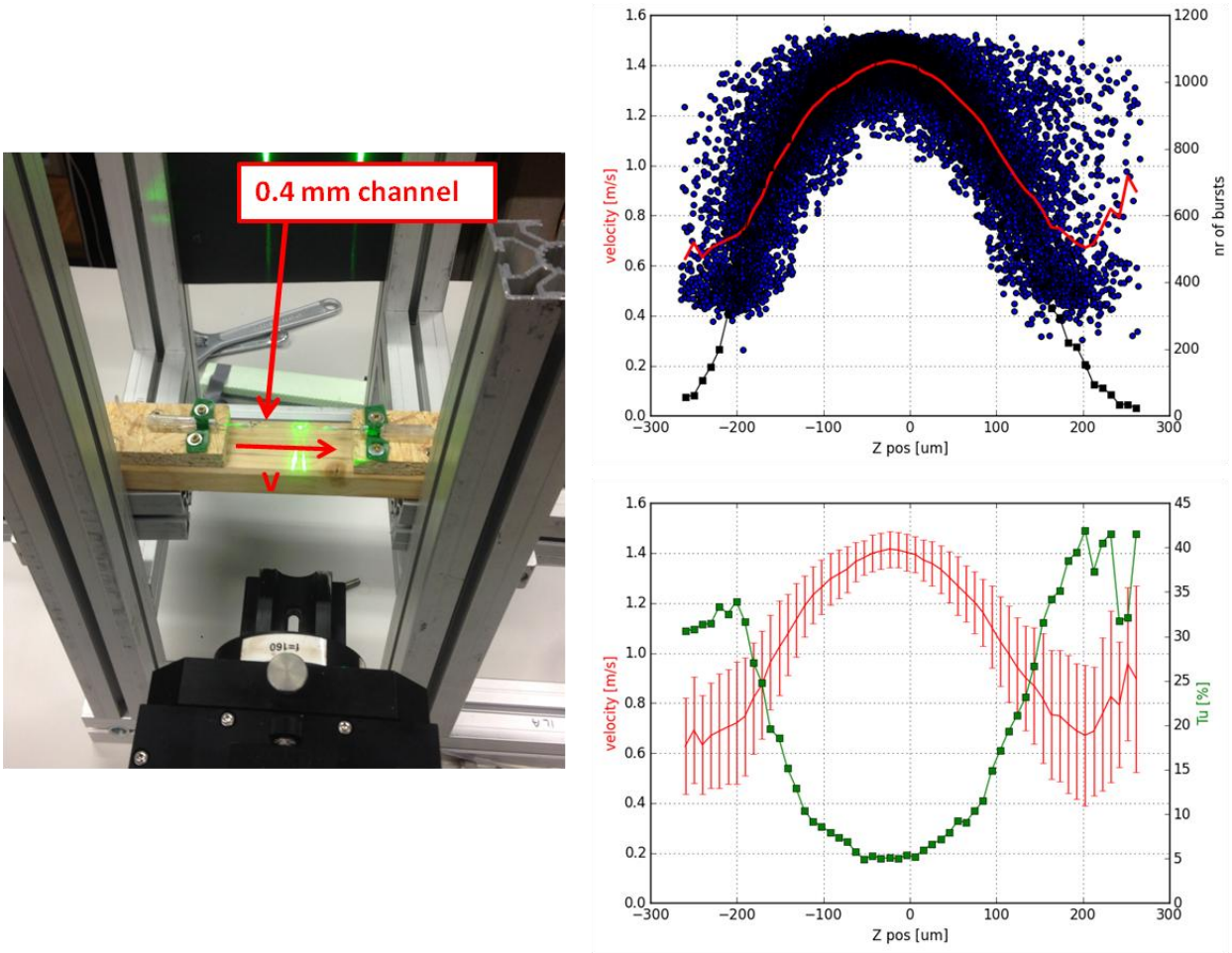

Fig 4: Measurement on microchannel testflow

The above taken measurements on a mikrochannel testflow show clearly the benefit of the Profile Sensor. It is possible to measure the entire velocity profile without traversing the probe. Conventional LDV is only capable to provide 2 - 4 independent local velocity measurements, which will be heavily biased by the high velocity gradients. As the measurement of the Profile Sensor delivers not only the velocity information also the relative position information of each particle transition, it shows a more clear picture about the flow. The Profile Sensor is a powerful measurement-tool to explore flows or sections of a flow, where spatial resolution becomes important (e.g. boundary layer, jet-flow, impingement-flow and etc.)

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