

miniLDV™

A Miniature Laser Doppler Velocimeter

Most LDV's in the industry are table-top systems which include the probe, an argon-ion laser, fiber manipulators for laser alignment, Bragg cells, and receiving and processing enclosures. Getting results quickly requires a user with experience in beam alignment. MSE's miniLDV replaces all these components with a probe and two small electronics boxes, decreasing the sensor system's overall size as well as its power consumption. Since all the sensitive optics are enclosed within the probe, the user does not need to spend hours setting up his sensor—and this leaves more time to perform measurements and collect valuable data.

The miniLDV is based on technology developed at the California Institute of Technology and NASA's Jet Propulsion Laboratories. Today there are customers around the world in academic, industrial, and research settings enjoying the reliability and ease of use of MSE's miniLDV.

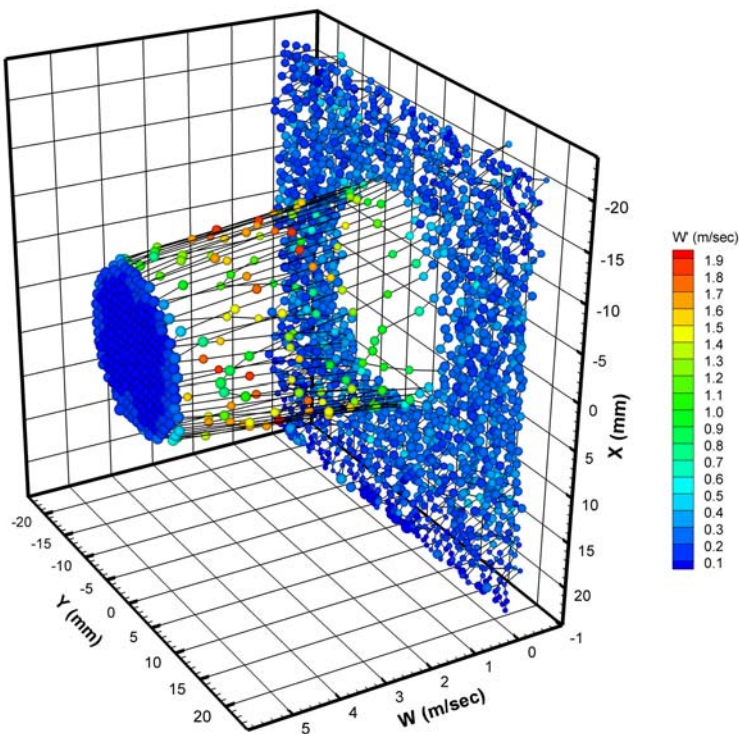


The miniLDV System

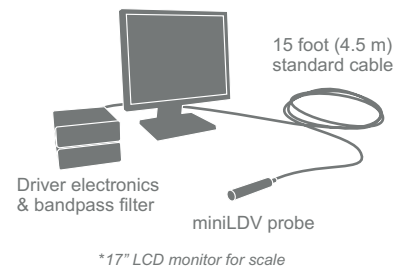
The miniLDV System consists of a transceiver probe, driver electronics, bandpass filter, and *BP-miniLDV Burst Processor* acquisition hardware and software. Optionally, the system can be ordered with a computer with the hardware and software installed and tested by MSE technicians.

The miniLDV System is a standalone system – no other lasers or optics are required. Simply place the electronics at a convenient distance to the acquisition computer and place your probe at the desired location. A 15-foot (4.5 m) cable is standard (longer lengths are optional). The Burst Processor software collects data, moves the probe on the optional electronic traverses, and presents flow statistics.

The process of measuring a profile is fully automated. The user simply dictates how many points per station to take, and the software does the rest. Such automation makes PIV-style full-field characterization a breeze.



Above: the out-of-plane component of velocity in the cross section of a turbulent jet near the nozzle exit, automatically collected in less than 2 hours by *BP-miniLDV* software. The measurement was collected in the 2-by-2-inch test section of the flowLab facility – the measurement would have been difficult with a Stereo PIV system. (Color corresponds to the RMS value of the out-of-plane velocity.)



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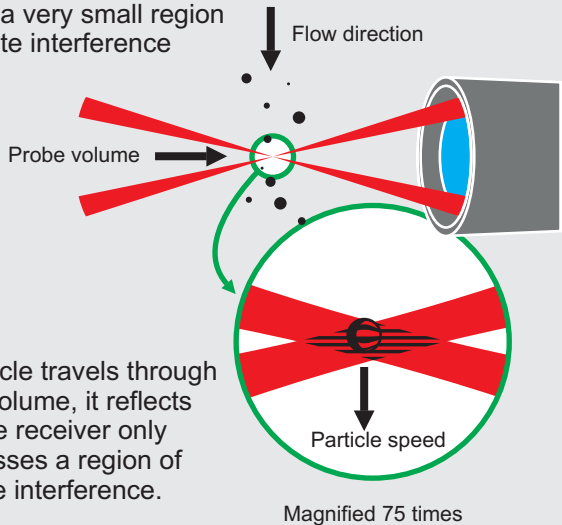
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The Laser Doppler Velocimetry Concept

Conceptually, an LDV system consists of highly coherent light split into two beams and sent through a *transmitter* which crosses the beams in the *probe volume* to create a fixed interference pattern. The aberrations of the optics must be low so that the fringes of the pattern are straight throughout the probe volume. The *receiver* consists of light collection optics and an ultra-fast-response photodiode. The optics are aligned so that any light reflected from the probe volume is focused onto the active area of a photodiode. When a particle passes through the probe volume, it passes through regions of destructive interference (darkness) and constructive interference (brightness) which the receiver sees a sinusoidal wave of intensity. Knowing the fringe separation (*calibrating* the given transmitter), the frequency of the sinusoid is a measure of the speed of the particle through the probe volume.

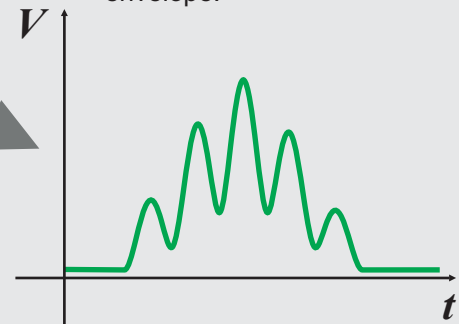
Sophisticated systems – including the miniLDV – include a frequency shifting component so that the fringes in the probe volume are moving at a constant velocity. The measurement then becomes one of the relative velocity difference between the particle in space and the fringes in the probe volume – thus such a probe can specify *flow direction* as well as measure speed.

The probe volume is formed by splitting a coherent beam and then crossing the two halves in a very small region to generate interference fringes.

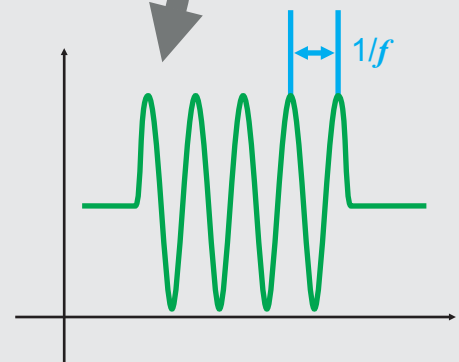


As the particle travels through the probe volume, it reflects light into the receiver only when it crosses a region of constructive interference.

As seen by the photodetector, the light signal is a sinusoid (corresponding to the fringes) modified by a Gaussian envelope.



The sinusoid is isolated by a bandpass frequency filter.



The frequency of the sinusoid is measured (usually by FFT). The fringe spacing is known (from calibration), thus the speed of the particle can be calculated.

$$\text{speed} = \text{fringe spacing} \times f$$

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