

# HiDense PDA system

Flexible PDA solution with powerful and compact lasers



*HiDense PDA system*

## The PDA solution for the most challenging particle sizing applications

Particle Dynamics Analysis (PDA) is a well-established technique to simultaneously measure the size and velocity of spherical particles. The HiDense PDA is a complete fiber-based PDA solution to precisely measure particles down to microns, with velocities up to hundreds of meters per second, even with ultra-high particle densities and in harsh environments. This makes it the ideal solution for studying particle behavior in complex applications such as fuel sprays and flows with cavitation.

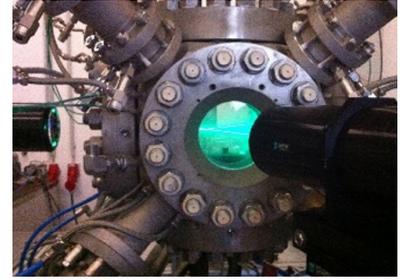
### Key benefits

- Powerful laser and large aperture receiver to detect and accurately measure particles down to 1 micron moving at up to supersonic velocity.
- User selectable masks to optimize size range
- User selectable slits to optimize for high particle densities
- Splash-proof fiber based transmitter and receiver optics, ideal for large scale sprays
- State-of-art signal processor handles ultra-high data rates
- User-friendly software with powerful post processing and display options

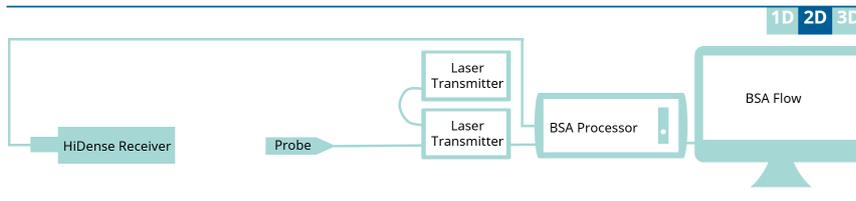
## The HiDense PDA solution in brief

Particle Dynamics Analysis (PDA) is an optical technique for non-intrusive measurement of diameter and velocity of spherical particles. The transmitter optics transmit two or more laser beams to the measurement volume, and generate an interference fringe pattern there. When a particle passes through the interference pattern, it scatters light modulated in intensity. The receiver optics collect scattered light, which is converted to electrical signals by photomultipliers. The frequency and phase of this signal contain information about the velocity and size of the particle.

The solution is based on four core components: Transmitting optics, Receiving optics, signal processor and software. Each is designed for the most challenging applications.



*PDA measurement in a dense fuel spray in a high pressure constant volume chamber (courtesy of LTT Erlangen, Germany)*



*HiDense PDA solution*

## Transmitting optics

### *Compact, powerful all-in-one FiberFlow laser transmitter*

Because the HiDense PDA uses high power lasers and a large aperture receiver, you will be able to measure micron sized particles even in dense sprays.

The laser transmitter is designed to maximize the laser power in the measurement volume, providing the best possible signal quality.

The FiberFlow probe can be configured with a range of focusing lenses, to match the desired velocity and size measurement range. An optional beam expander can further adapt the measurement range to best fit your application.



*FiberFlow Laser Transmitter and Probe*

## Receiving optics

### *HiDense PDA receiver*

The HiDense PDA receiver collects light scattered from the particles to be processed later. The HiDense PDA receiver is designed with a large aperture to allow maximum collection of light to improve the signal quality. This is essential to collect weak signals from micron sized particles.

The HiDense PDA receiver includes a set of interchangeable spatial filters (slits and pinhole), with widths from 25  $\mu\text{m}$  to 200  $\mu\text{m}$ , mounted on a selector. They allow you to spatially filter the measurement volume in order to handle different particle concentrations. The 25  $\mu\text{m}$  pinhole is designed to cope with the ultra-high particle concentrations in dense sprays such as diesel sprays.

The HiDense PDA receiver further includes three easily exchangeable aperture masks, allowing you to optimize the size measurement range without changing and realigning any optics.



*HiDense receiving optics with spatial filter selector*

## Processor

### *Fast & powerful all-in-one processor*

The Doppler signal collected by HiDense PDA receiver is processed by the signal processor, to provide size and velocity results. The HiDense PDA solution includes the new third generation Burst Spectrum Analyzer (BSA), which uses the latest signal processing technology to be the fastest and most powerful processor for PDA systems.

The new generation BSA is able to easily process signals with an input frequency of up to 200 MHz and up to 160 MHz bandwidth. This makes it possible to measure particles with wide velocity range and up to more than 2000 m/s. The BSA handles particle rates up to more than 100,000 per second, using the latest digital technology.

The HiDense PDA solution provides real time measurements and on-line monitoring of Doppler bursts, spectra, size and velocity data, data rate, validation rate and more.

PDA measurements require accurate measurement of the phase differences of light signals detected from different perspectives, which is processed by different channels inside the processor. This requires phase calibration on the electronics. This process is fully automatic, with no effort from you. In addition, the BSA automatically protects the photomultipliers against saturation and potential damage from strong light reflections, extending their lifetime and protecting your investment.

For further details on the processing performance, please consult separate data sheet on "Burst Spectrum Analyzer (BSA)" on our website.



*Spray nozzle quality control with HiDense PDA system (courtesy of Lechler GmbH, Germany)*

## Data Analysis

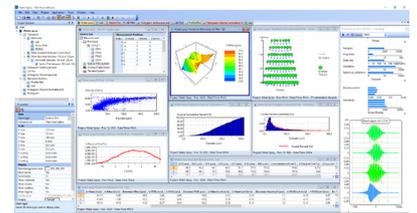
### *Flexible and user-experience focused software platform*

The BSA Flow software is comprehensive, easy to use, and includes extensive graphics and data exchange features. The system setup including the optical configuration as well as processor settings is controlled via the software. Tools are provided which enables user-defined data analysis and display, which is dynamically updated during measurements.

Data analysis can be customized with a built-in Calculation module as well as a MatLab link for ultimate flexibility. Graphical output includes vector plots, 2D line and scatter plots, and 3D plots. Graphic results can be transferred to a measurement report in pdf or HTML format. Numerical output includes binary, ASCII, MS Excel, and TecPlot formats.

BSA Flow includes an automatic report function to help you quickly organize and export the results. The user defines the plots and statistics to be included in the report and a PDF or html document is generated.

For further details on the software performance, please consult separate data sheet on "BSA Flow Software" on our website.



*BSA Flow with Particle Sizing add-on and Advanced Graphics add-on*

## Technical specifications

Optics	Low power	High power
<b>Laser wavelength</b>	532, 561 and 553 nm	532, 546 and 520 nm
<b>Laser power</b>	100, 100 and 100 mW, 300, 300 mW and 200 mW	1 W for each laser
<b>Laser Type</b>	Diode pumped solid state (DPSS)	Fiber laser
<b>Transmitting optics</b>	Fiber Flow probe, (Diameter: 60 mm or 112 mm)	
<b>Receiving optics</b>	HiDense PDA fiber-based receiver probe: Diameter 112mm; interchangeable spatial filters (3 slits + a pinhole); options of three masks to adapt different size range;	
<b>Focal lengths</b>	160 mm, 240 mm, 310 mm, 500 mm, 800 mm, 1000 mm; All lenses are Achromatic	



Processor	BSA P600	BSA P800
Max. input frequency	120 MHz	200 MHz
Velocity range <sup>*)</sup>	228 m/s	576 m/s
Data rate	>100,000 bursts/sec	
Resolution	>16 bits	

\*) depends on the optics, example for 112 mm probe with 500 mm focal length, 532 nm wavelength

Software	Features
BSA Flow	Online oscilloscope display of signals Online display of data validation, data rate, coincidence rate, photomultiplier anode current Set up of BSA processor Acquisition of data from BSA, Control of traversing system Statistics of results (mean, RMS, Skewness and Flatness) Listing of results Set up of analysis sequences Export of data
Advanced Graphics Add-on	X-Y plots, vector plots, 3D plots, velocity profile plots
Particle Sizing Add-on	Add on for PDA measurement, data analysis and result presentation