Integrated solutions in Particle Dynamics Analysis
Dantec Dynamics’ Particle Dynamics Analysis (PDA) systems measure on-line the size, velocity and concentration of spherical particles, droplets or bubbles suspended in gaseous or liquid flows.

**PDA applications**
The most popular application is the analysis of atomised liquids (sprays). Sprays are used in countless applications, both in industrial processes and commercial products. The spray nozzle has a decisive influence on the distribution and droplet size of the atomised liquid in applications such as:

- Fuel injection
- Spray painting
- Liquid metal sprays
- Pharmaceutical sprays

Dantec Dynamics’ new Burst Spectrum Analysers are FFT based signal processors featuring large bandwidth and 16-bit resolution of data output. Every element in these processors has been newly developed, incorporating the very latest in DSP technology and digital filtering. They represent the state of the art in PDA measurement. Together with Dantec Dynamics’ high-quality laser light transmitting/receiving optics and BSA Flow Software package, these new processors provide a total solution for PDA.

The BSA’s large bandwidth makes it very suitable for applications with high velocities and high turbulence levels. Prime examples are research into fuel injection and aircraft icing phenomena. Other applications include studies of sedimentation and particle transport, metal powder generation, cavitation research and bubble dynamics.

**BSA Flow Software**
Dantec Dynamics’ BSA Flow Software is the user-friendly application software package for Dantec Dynamics’ PDA systems. The software package features:

- User-defined analysis sequences
- End-results on-line
- Project templates
- Fast access to data
- Wizards for quick experiment set-up
- Simplified system monitoring
- On-line Doppler Burst Monitor

**Transmitting optics - FiberFlow and FlowLite optics**

- High-accuracy probes
- Probe diameters of 14, 27, 60, 85 and 112 mm
- Wide choice of front lenses, beam expanders and probe supports

**Receiving optics - FiberPDA and DualPDA optics**

- Large aperture probe (112 mm) with exchangeable spatial filter or compact probe (60 mm)
- High quality probes based on fibre technology with up to four receiving apertures in one integrated unit
- Yields a large measurable size range while maintaining a high resolution
- A large selection of front lenses and beam expanders provides the flexibility to adapt the system to specific requirements

**Traverse System**

- Modular traverse systems compatible with the PDA optics
- The traverse systems are fully controlled by the BSA Flow Software

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*Detailed droplet size and velocity measurements in a fuel injection spray using a Dantec Dynamics PDA system. Photo courtesy of DLR Institute of Propulsion Technology.*
The principles of Particle Dynamics Analysis (PDA)

A) The measurements are performed at the intersection of two laser beams, where there is an interference fringe pattern of alternating light and dark planes.

B) Particles scatter the light, which appears to flash, as the particles pass through the bright planes of the interference pattern. Receiving optics placed at an off-axis location focus scattered light onto multiple detectors.

C) Each detector converts the optical signal into a Doppler burst with a frequency linearly proportional to the particle velocity.

D) The processor measures the phase difference between the Doppler signals from different detectors. This is a direct measure of the particle diameter.

E) Results are processed by the BSA Flow Software Packages.

A complete Dantec Dynamics PDA system.
Particle Dynamics Analysers can be used for a wide range of applications, where detailed information on the size and velocity of individual droplets, bubbles or spherical solid particles is needed. These applications are related to research activities at universities or research centres as well as for industrial process optimisation.

**Liquid metal spray**
Spray-forming processes involve the atomisation of a molten metal stream by means of a high-speed gas jet. The resulting droplets are then convected by the gas stream towards the substrate on which the partly solidified droplets build up a homogeneous deposit. Spray-forming combines the main advantages of conventional casting and sintering, and the resulting deposits have improved material properties.

**Pharmaceutical sprays**
Droplet size measurements can be made in the aerosol generated by small handheld nebulisers. The ability of small aerosol droplets to be deposited in the human lung or nasal tract depends very much on the size of the droplets. The long term temporal stability of the aerosol generation is also important.

**Optimisation of cyclones**
Although cyclones are frequently used in chemical and process engineering plants to separate solid particles from a gaseous or liquid carrier phase, detailed knowledge about the separation process in a cyclone - especially of small particles - is lacking. To improve the understanding of the working mechanism and to facilitate the optimisation of cyclones, it is necessary to know the flow field and obtain information about the particle distribution inside cyclones.

**Spray painting**
The investigation and optimisation of spray painting is attracting increased interest for several reasons, among which environmental and quality aspects are the most important. Minimising the quantity of over-spray is one of the key issues. The Particle Dynamics Analyser, with its ability to measure the size and velocity of droplets simultaneously, even in highly concentrated particle systems, is a powerful tool for this research task.

**Bubble dynamics and cavitation**
Two-phase flows, where a gaseous phase is dispersed in a liquid carrier phase, play an important role in many industrial processes. The dispersed gaseous phase quite often exists in the form of discrete bubbles. The size distribution of the bubbles affects the process under consideration: mass transfer for example, or the cavitation, noise, erosion and reduced efficiency of ship propeller blades.

**Combustion: automotive and aero engine fuel injectors**
Dantec Dynamics systems are widely used by engineers in the automotive and aerospace industries to study flows inside engines and thereby obtain important data on the fuel injection, combustion and mixing processes. The benefits derived from these data include improvements in fuel efficiency, fuel distribution and homogeneity, lower noise levels and reductions in pollutant emissions.
Engine fuel injector study using a Dantec Dynamics PDA system. Photo courtesy of AVL.

Cavitation measurement near the blades of a propeller.

Automobile spray painting. Photo courtesy of DaimlerChrysler.
A Dantec Dynamics PDA system comprises transmitting and receiving optics, a processor and BSA Flow Software package. The optics are integrated and compact probes provide all the required features for easy alignment. A large selection of front lenses and beam expanders provides flexibility to adapt to your specific requirements.

**Transmitting optics**

**FiberFlow**
The FiberFlow optical system offers a wide selection of probes and accessories. The modularity of the system gives the user considerable flexibility in configuring the transmitting optics. Both the number of measured velocity components and the measuring distance can be adapted to individual requirements.

FiberFlow is designed for use with Argon-Ion lasers, and consists of a transmitter, fibre manipulators, one or more probes with an optical fibre connection to the transmitter, and front optics. Five probe diameters are available: 14, 27, 60, 85 and 112 mm. The measurement distance ranges from 50 mm for the 14 mm diameter probes, to several metres using the largest probes. A number of front lenses, beam expanders and other accessories is available for each probe.

**FlowLite**
The FlowLite system is a turnkey solution with no adjustments. It consists of a unit containing the laser(s), beam splitters, Bragg cell and photodetector(s). It is connected to a probe via a fibre cable. Systems capable of measuring one or two velocity components are available. Probe diameters of 14, 27 and 60 mm are available, covering measuring distances from 50 mm to 1 m, depending on probe size.

Dantec Dynamics’ total solution for Particle Dynamics Analysis: the new BSA P80 processor, the PDA detector unit, the transmitting and receiving optics system and the BSA Flow Software Package.
Receiving optics

FiberPDA
The FiberPDA receiving probe is based on fibre technology with three receiving apertures. This configuration yields a large measurable size range while maintaining high resolution. A large selection of front lenses, beam expanders and spatial filters (112 mm probe) and easily exchangeable aperture masks provides the flexibility to adapt the system to measurement distance, size and velocity range.

The FiberPDA receiving probe is connected to the detector unit through a fibre cable containing three receiving fibres. The detector unit contains three, four or five photomultipliers, depending on the number of velocity components to be measured (1, 2 or 3).

The FiberPDA probe and detector unit can be upgraded to the DualPDA configuration.

DualPDA
The DualPDA is based on a novel concept that yields higher measurement accuracy, particularly for spray analysis and other investigations of liquid atomisation. The DualPDA receiving probe contains four receiving apertures integrated into one single optical unit. The DualPDA detector configuration (2 standard and 2 planar), minimizes misinterpreted size measurements due to trajectory effects. The DualPDA permits the measurement of 2 velocity component and is easily extendable to 3 components.

The DualPDA offers the same configuration flexibility as the FiberPDA solution.
Increasing your knowledge
Our business philosophy is based on openness. The ever-increasing body of knowledge that we acquire is knowledge we share with our customers. With Dantec Dynamics as your business partner, you are ensured access to a full range of relevant and regularly updated information via our website. Why not take an initial look right now? It’s just a click away at www.dantecdynamics.com

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Sales and support offices in USA, Japan, Denmark, France, Germany and UK. Representatives in more than 30 countries. A list of representatives with contact information is available on www.dantecdynamics.com/contact/representatives

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