SOLUTION SHEET

DANTEC DYNAMICS

ParticleSight E

All-in-one system for measuring size, shape and velocity of particles and bubbles



Endoscopic imaging probe for industrial multiphase flows

The ParticleSight E is a seamlessly integrated solution for measuring size, shape parameters, and velocity of particles and bubbles using the shadow imaging technique.

As many industrial processes involve reactive multiphase flows within intricate machinery, this innovative endoscope-like solution allows to see into environments with challenging optical access, enabling accurate measurement of critical flow parameters which are essential for understanding and optimizing these processes.

The probe incorporates an eye-safe LED back-illumination source and a variable measurement volume, using long-distance telecentric optics. Coupled with a performant imaging system and the cutting-edge image processing capabilities of DynamicStudio, ParticleSight E delivers particle flow information otherwise unattainable with standard borescope/ endoscope imaging instruments.

Key benefits

- Measures size, shape parameters, and velocity of particles and bubbles using the shadow imaging technique
- Integrated IP68 (max. 0.5 Bar) watertight probe for alignment-free endoscopic imaging
- Variable measurement volume for adapting to many flow conditions
- High-resolution camera system for capturing fast and fine details of the flow
- User-friendly DynamicStudio software for data acquisition and analysis

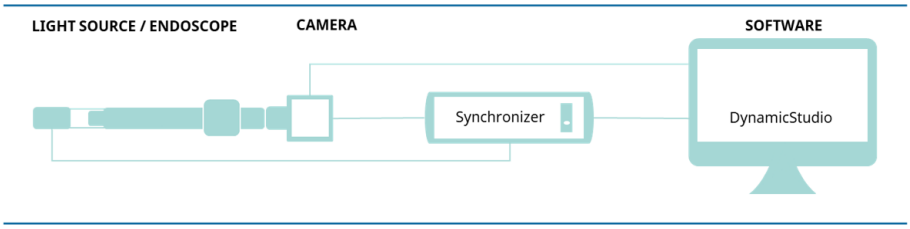
NOVA INSTRUMENTS

Endoscopic shadow imaging measurement solution

In many industrial multi-phase flow applications, it is rarely possible to have clear optical access for placing imaging optics and/or illumination sources for inspection. Quite often these processes happen in closed reactors or pipes, making the use of classical imaging devices impossible for studying and/or optimizing operating conditions. For these cases, the ParticleSight E was designed to be used inside the measurement unit or apparatus, requiring only a single access port for the probe tip into the desired flow measurement location.

The solution in brief

The ParticleSight solution uses the shadow imaging technique for mapping particles' size, velocity, and shape in multi-phase flow processes. The system is very much "what you see, is what you get", making it very easy to operate and to understand the principle – in fact, just as simple as taking pictures of the flow.

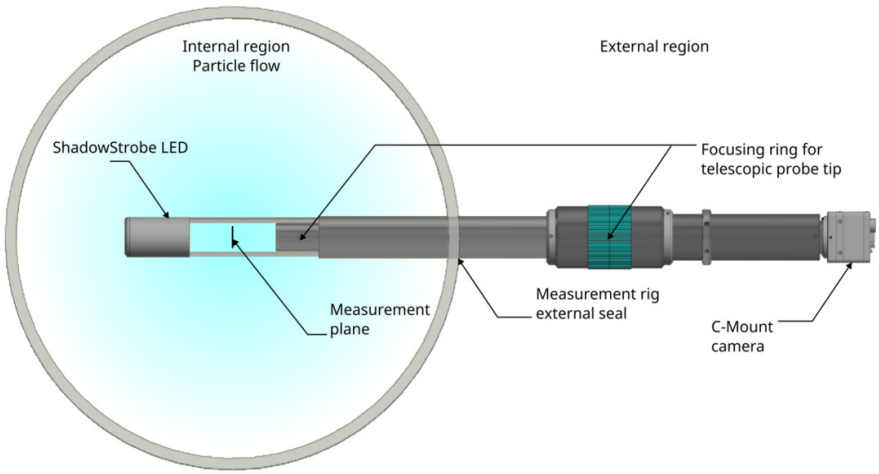


Overview of the different components, timing, and data flow

Combining a fast, bright, and collimated LED back-illumination source, together with a long-distance telecentric optics into a single watertight IP68 probe, the solution provides the most accurate image quality for particle sizing and tracking. Specially developed for bubbly flows or particle flows in liquids, the probe can be attached to a FlowSense FCX camera, together with a Synchronizer and DynamicStudio image acquisition and analysis.



ParticleSight E measuring bubbles' size distributions in a prototype reactor. Courtesy of GEA, Bioreactor Technologies, Denmark.

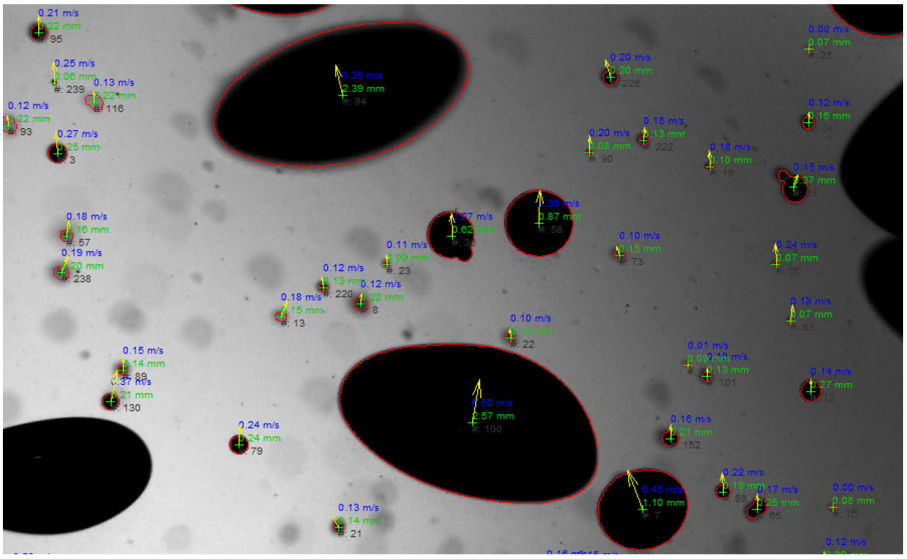


Example of the ParticleSight E inserted on a bubble column reactor, placing the measurement plane and volume at the middle of the flow.

Typical application

One of the main challenges in measuring particle flows at large volume fractions is defining an adequate measurement volume, aiming to avoid object's occlusion while also minimizing the probe's interference in the flow.

For this, ParticleSight E has a manual adjustable telescopic optics on the camera side. This allows to change both the focal distance and the measurement volume from the outside, giving maximum flexibility when adapting to many flow conditions and particle concentrations without having to unmount and reposition the probe.



Shadow images from a typical polydisperse bubbly flow. Overlay of post-processing using the Shadow Sizing Add-on in DynamicStudio, showing bubbles' contours, sizes and velocity vectors.

In the case shown above, bubbles can be easily tracked by adapting the telescopic optics to reduce the measurement volume, allowing for clear individual bubbles detection in each frame. Moreover, even small out-of-focus particles can be detected and correctly sized thanks to the embedded telecentric optics.



FlowSense FCX and FlowSense USB cameras.

Camera

With focus on having the best possible particle image quality, the FlowSense FCX 5M-124 (124 fps) or the new FlowSense FCX2 5M-260 (260 fps) provides short inter-frame times and small pixel size at 5 MP resolution, allowing you to measure particle distributions in a wide dynamic range of sizes and velocities.

With the latest CMOS back-illuminated sensors, they provide great sensitivity, extended dynamic range coupled with extremely robust blooming suppression for clean imaging even in the most challenging applications.

Using the latest generation of CoaXPress 12 connectivity, the FlowSense FCX cameras need only a single cable connection (two for FCX2) to provide synchronization, power, and data link.

For entry-level systems, the FlowSense USB 2M-165 camera offers the ideal solution when it comes to performance and ease of use. With its USB interface, the camera can be used with a USB 3.0 PC or laptop without the need for frame grabbers or other hardware. At 1920 x 1200 pixels, the CMOS sensor is capable of 165 frames per second and higher frame rates with reduced region of interest.

Synchronization

The synchronizer ensures that all devices perform their individual tasks at the exact right time. For the ParticleSight E system, the Synchronizer handles the precise camera shutter timings and the LED pulsed illumination, allowing for fast stroboscopic back-illumination even in tight inter-frame times. The end result is sharp and motion-blur free particle images, even at high velocities.

For a compact shadow system, the Mini Synchronizer 3 with three synchronization outputs is ideal to synchronize the built in LED and camera. One additional output can be used to trigger another device. An external trigger input is available to synchronize measurements (image acquisitions) with external events e.g. to start acquisition at the same time a pump is starting.

By selecting the Performance Synchronizer, the use of e.g., the Ethernet interface makes it possible to place the processor synchronizer near the experiment and the PC in a control room at some distance. The Performance Synchronizer is a powerful tool for handling not only the images acquisition but also the simultaneous acquisition from other sensors or timing of external devices in the experimental/industrial setup.



Performance Synchronizer



Mini Synchronizer

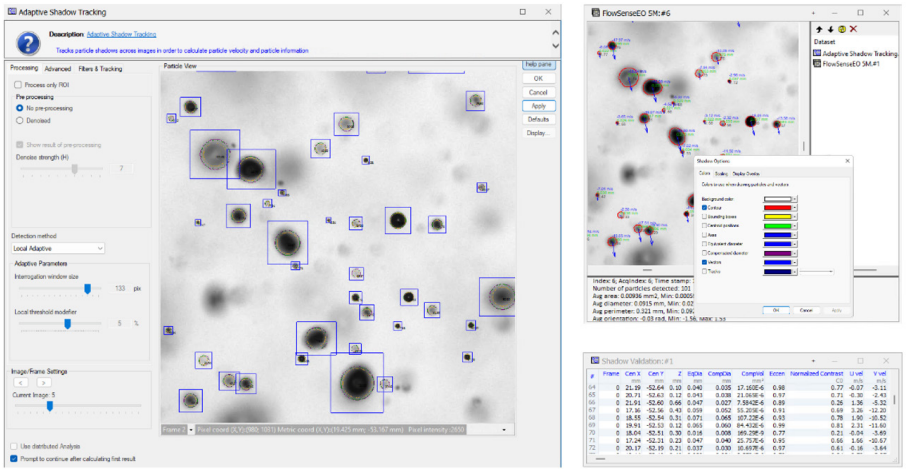
Software

DynamicStudio is a complete software platform designed to support a wide range of imaging measurements within fluid dynamics, solid mechanics, microfluidics, spray/particle analysis, mixing and combustion diagnostics, and flow visualization.

The modular concept provides users with many add-ons so that system functionality can be tailored to current needs while also allowing expansion to meet future measurement requirements.

The Shadow Sizing Add-On bundles the most important methods to analyze shadow images for particle characterization.

From bubbly flows, sprays, or general multiphase flows; image processing/ analysis provides in-depth information otherwise not accessible like in point-measurement techniques (wire probes, PDA).



Adaptive Shadow Tracking method in DynamicStudio. Particle detection shown using both particle display overlay and table, allowing quick visualization of key parameters such as velocity, size, eccentricity, etc.

By leveraging state-of-the-art image processing, it is possible to accurately detect, track, and extract useful parameters from the imaged particles.

Moreover, the built-in post-processing tools allow quick visualization and key statistics calculations, for either quick diagnostics or custom analyses using external tools.

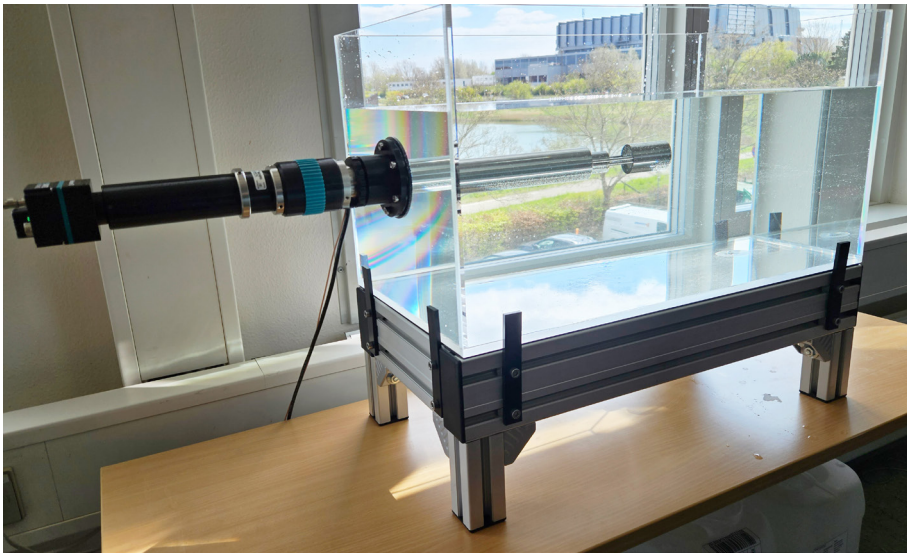
Options

Demo Bubbly Flow

A fully functional demonstration flow is provided with the system as an option. To train and test the functionality of ParticleSight E, we developed this demo bubbly flow to showcase the potential of doing particle detection by shadow imaging.

The test rig consists of a simple squared shaped 60 L transparent acrylic water tank, built on top of a convenient table-top structure and feet. The probe is inserted horizontally, and it is kept in place thanks to a lockable ring. Water is simply filled up from the top and drained from a valve located at the bottom for easy operation and cleaning.

Bubbles are generated using a standard fine gas diffuser, which operates at a nominal pressure of 2 bars and is fed from an included small electric compressor pump. The resulting bubbly flow that can be adjusted to showcase the ParticleSight E measurement capabilities at different bubble velocities, sizes, and concentrations. In particular, the capability of adapting the measurement gap (volume) by adjusting the telescopic tip, to optimize the visualization of the particle flow at high concentrations.



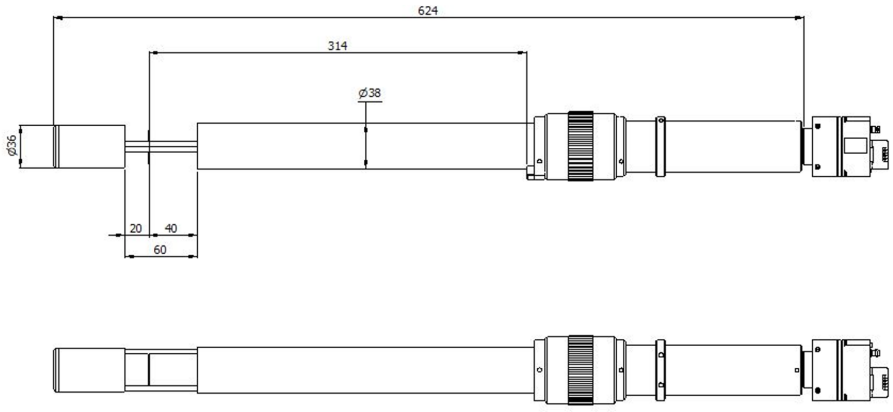
Demo bubbly flow rig for ParticleSight E. Including transparent 60 L tank, frame with tabletop feet, probe seal mechanism and bubble generator with electrical compressor pump.



ParticleSight E measuring bubbles' size distributions in a demo bubbly-flow rig.

Technical specifications

The following table lists the specifications of the ParticleSight E probe (9083X0501). For the other components, please refer to the individual components datasheets or contact your local Dantec Dynamics representative.

Item no. 9083X0501	
Material	Stainless steel
Operating Temperature	0° C to 40° C
Measurement gap	20 – 60 mm, manually adjusted from the outside
Field-of-view	Max. 14,3 × 11,5 mm^2
Weight	4 kg (without camera)
Ingress rating	IP68, up to max 0.5 bar hydrostatic pressure (when sealed from internal flow, see usage schematic)
Compatible with	C-Mount Camera (max. 1/1.8” sensor): FlowSense FCX 5M-124 (9081C0841) FlowSense USB 2M-165* (9081C0521) *with sensor cropped to max 1/1.8” format
Nominal measurement capabilities (Camera dependant)	FlowSense FCX 5M: Max Velocity* 100 m/s (double-frame mode). 0.06 m/s (without double-frame). Min. Part. size 13 µm FlowSense USB 2M 15 m/s (double-frame mode). | 0.15 m/s (without double-frame). Min. Part. size 30 µm *Velocity with respect to a 100 µm particle, might be lower for smaller particles.
Included the delivery	- Tools for assembly and adjustment - LED power adapter, 7,5V 2.0A - User’s guide
Main dimensions	

Disclaimer

The probe unit and LED enclosure have an IP68 rating (up to max 0.5 bar hydrostatic pressure - max. 5 m water depth) provided that a seal mechanism is added on any location of the Φ38,2 mm external side of the probe.

Ordering information

The typical components for the ParticleSight E solution are listed here. For additional information on other relevant cameras, options, etc., please contact your local Dantec Dynamics representative.

Category	Item	Item no.
Probe	**ParticleSight E** Endoscopic shadowgraphic probe for measuring particle flows submerged in liquids (IP68 for water). Note: up to max 0.5 bar hydrostatic pressure - max. 5 m water depth). Bore diameter 38,2 mm. Max working distance 324 mm. For camera sensors up to 1/1.8" format. Includes stroboscopic backlight LED (requires Synchronizer 9081N0201)	9083X0501
Camera	**(Option 1) FlowSense FCX 5M-124 Camera** 2448 x 2048 px, max 124 fps, min. delta t = 1 µs (0.1 µs with option 9081C0801), 8 or 12-Bit 2.74 µm pixel size. Backside illuminated CMOS sensor for high QE. Includes 5m Cable. Requires CoaXPress12 frame grabber 9081C0811	9081C0841
	(Option 2) FlowSense USB 2M-165 Camera 2.3MP 1920 x 1200 px, max 165 fps, USB 3 Board for max, transfer rates, min. delta t = 65 µs, recommended for slow water flows.	9081C0221
	(Option 3) FlowSense USB 2M-165 Camera 2.3MP 1920 x 1200 px, max 165 fps, USB 3 Board for max, transfer rates, min. delta t = 65 µs, recommended for slow water flows.	9081C0521
Software	**DynamicStudio Base Package** Dynamic Studio: Innovative, secure, and scalable network-based imaging software platform. Includes automatic device detection, distributed acquisition, distributed database, camera support, cyclic phenomena, image stitching, image processing library, MatLab link and much more.	9080S0571
	DynamicStudio ShadowSizer Add-on Includes Adaptive Shadow Tracking, Shadow Calibration, and Shadow Statistics methods to detect and analyze particle sizes, shape parameters and velocities.	9080S0481
Electronics	**Performance Synchronizer** Time resolution <= 8ns. Min. pulse width <= 48ns. 32 Sync outputs. 4 Sync inputs. 4 analog outputs. 2 analog inputs. Safety circuit. USB & Ethernet.	9081N0201
	Mini Synchronizer 3 (or 6*) Time resolution 25 ns. Min. pulse width 50 ns. 3 (or 6*) Sync outputs. 1 Sync inputs. Safety circuit. USB & Ethernet.	9081N0711 (*9081N0701)
	Performance Imaging PC for a 1-Cam imaging system	9081N0111
	CoaXpress12 Frame Grabber 4.ch for FlowSense FCX Series Required for 9081C0841	9081C0811
Demo Setup (Optional)	**Bubbly flow rig for ParticleSight E** 60 L water tank for demonstration of the ParticleSight E probe, including acrylic tank, frame with table-top feet, probe seal and drain tube and bubble generation system.	9083X0511

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