

Cameras for PIV, PLIF, and GSV



*TSI has the right camera
for your imaging measurements*

Using the right camera for your global imaging measurements gives you a head-start in obtaining high-quality results. We start with high image quality to help obtain measurements when other cameras fail. Flexibility is designed into POWERVIEW™ cameras from TSI, so they can be used for several applications with the INSIGHT 3G™ software package. Finally, the protective mask on TSI cameras gives you longer lasting operation.

High Image Quality

POWERVIEW cameras from TSI have an unusually low noise level due to their unique electronic design. The CCD and its digitization circuit are completely shielded to prevent electronic noise from the camera and its environment from affecting signal quality. POWERVIEW cameras are designed for laser based imaging, which means the maximum quantum efficiency is matched to typical YAG laser wavelengths used for PIV and PLIF measurements.

Flexibility designed in every POWERVIEW camera

POWERVIEW cameras use the latest techniques in circuit board design to make very small size electronic circuit boards. This means the camera can be made very small, such as the POWERVIEW Plus 2MP, with dimensions 45mm x 68mm x 66mm.



2MP

The latest *INSIGHT 3G* software works seamlessly with the POWERVIEW cameras for global image capture and analysis. It controls image capture and data transfer in single and stereo arrangements for both PIV and PLIF. Critical analysis schemes, such as the patented Hart Correlation, Rohaly-Hart Correlation, and deformation processing, are incorporated to ensure accurate PIV analysis. Image analysis, manipulation and in-situ calibration are provided for PLIF intensity measurements. The Tecplot® graphical display and analysis package is integrated with the *INSIGHT 3G* software, enabling seamless, on-line graphical display and data manipulation along with advanced flow statistics and property computation.

Reliable and Long Lasting Operation

An integrated protective mask on the CCD or CMOS array is included on POWERVIEW cameras. The TSI mask is important for preventing fatal damage to the output circuit of the CCD or CMOS chip due to laser light reflections. This key feature of POWERVIEW Plus cameras improves reliability and extends the camera life.

POWERVIEW Cameras fit your Experimental Needs

Compact and light weight, POWERVIEW cameras are being used in many applications all over the world. Some applications require remote focusing system, which is available for POWERVIEW cameras. This allows the camera to be located in hazardous or hard-to-reach locations. If the camera is located far from the operator's station, an extended CameraLink cable or even a fiber optic cable are available as options. A TSI Model 610015 Light Arm helps you deliver the light sheet where you want it, in a safe and convenient manner.

Cameras designed for PIV, Stereoscopic-PIV, and Super Resolution PIV

The POWERVIEW Plus 2MP, 4MP, and 11MP Cameras cover a wide range of applications, including smaller wind tunnels, duct flows, water flows, and boundary layer flows. The POWERVIEW Plus 4MP is recommended for turbulence studies, water flows, larger field-of-view measurements, combustion flows, and hypersonic flows. Frame straddling times to 200 ns allow the camera to make accurate flow measurements in high speed



4MP

flows. A binning capability, with horizontal and vertical pixel binning, increases image capture sensitivity, a feature particularly useful for PLIF concentration/temperature measurements. Pixel binning also results in increased frame rate. The variable exposure time settings for the image frame allow multiple laser pulses in the same frame to do in-camera integration. This makes the POWERVIEW Plus 11MP suitable for large area PIV, Super Resolution Particle Velocimetry, and PLIF measurements.



11MP

Cameras designed for High Frame Rate PIV

For time resolved PIV, the camera can be operated in frame straddling mode to allow a small laser pulse separation in two consecutive frames. This is the basis of cross correlation image analysis. Various *INSIGHT 3G* Matlab® based

Toolboxes developed by TSI (Time series, POD), provide flow statistics, spectrum analysis and turbulence analysis, all of which are useful for time-resolved PIV

measurements. The POWERVIEW HS-200 camera can be used to acquire images at 200 frames per second (FPS) and combined with *HyperStreaming* to continuously capture for up to about 20 minutes. The HS-650 camera captures at up to 650 FPS, and has higher resolution than the HS200. These cameras are suitable for water flows, lower speed air flows, and biological flows. The HS2000 and HS3000 cameras offer the highest capture rates possible with a 1k x 1k image resolution. The HS2000 and HS3000 are preferred for high-speed events like engine flows, sprays, mixing, turbulence evolution, and combustion.



HS-200



HS-650

Cameras Designed for PLIF and Micro-PHS-650

In PLIF, we use a laser to illuminate dye molecules in the flow, or fluorescent particles. The camera collects only the fluorescence signal, which is much weaker than the original laser light intensity. Therefore PLIF measurements require very high sensitivity, low noise, and sometimes long exposure times. In liquids, PLIF measurements yield qualitative and quantitative imaging of concentration and temperature.

Mixing experiments and reactor flows benefit from PLIF measurements. In the gas phase, PLIF measurements yield qualitative and quantitative imaging of species concentration (OH, CH, CHO, NO), and



HS-2000

also flame location, burning zones, mixing, etc. Micro-PIV has similar requirements due to the illumination method and small particle size. The POWERVIEW 1.4MP Camera has a high-performance two-stage cooling system (Peltier + forced air) that provides lower dark current and lower camera noise. This is a distinct advantage for long exposure time PLIF applications and micro-PIV applications. The Dicam Pro series intensified cameras from PCO can also be used in an *INSIGHT 3G* based PLIF system. Different cameras can be used under *INSIGHT 3G*, if combined PLIF and PIV measurements are being made. Up to two 64 bit frame grabbers can be used in the host PC for multi-camera applications like PIV and PLIF.

Cameras Designed for Imaging Measurements

In Global Size and Velocimetry (GSV) and Spray Analysis we illuminate a section of a spray and obtain macroscopic information on the spray shape and uniformity by patternation, or statistical information on droplet size and velocity by GSV. These imaging measurements require a rugged but easy-to-use camera like the POWERVIEW Plus 2MP or 4MP. These cameras have a good balance of pixel resolution and speed. Their 7.4µm pixel size gives a wide diameter range in GSV measurements. Combined with a standard GSV 105mm lens, the 4MP offers a large 225mm² analysis area for typical GSV magnifications.



HS-3000

The table below can be used to help select the right TSI POWERVIEW camera for your measurement needs. Contact your local TSI sales manager or representative for any additional information.

TSI Camera Lineup

Camera Model	Pixel Resolution (Pixels)	Pixel size (µm)	Output Resolution (Bits)	Frame Rate ¹ (FPS)	Spectral Range (nm)	Quantum Efficiency (max.)	Interface Type
POWERVIEW Plus 2MP	1600 x 1200	7.4 x 7.4	12 bit	32	340 - 720	58%	64 bit CameraLink
POWERVIEW Plus 4MP	2048 x 2048	7.4 x 7.4	12 bit	15	350 - 740	57%	64 bit CameraLink
POWERVIEW Plus 11MP	4008 x 2672	9.0 x 9.0	12 bit	4.8	340 - 730	50%	64 bit CameraLink
POWERVIEW 1.4MP	1376 x 1040	6.45 x 6.45	12 bit	10	270 - 1100	62%	PCI Based
POWERVIEW HS-200	640 x 480	7.4 x 7.4	12 bit	200	380 - 700	55%	64 bit CameraLink
POWERVIEW HS-650	1280 x 1024	12 x 12	10 bit	636	290 - 1100	-	FireWire®
POWERVIEW HS-2000	1024 x 1024	17.4 x 17.4	8 bit	2000, 120,000 max	400 - 700	-	FireWire®
POWERVIEW HS-3000	1024 x 1024	17.4 x 17.4	8 bit	3000, 250,000 max	400 - 700	-	FireWire®

Notes: 1. Frame rate at maximum resolution, i.e. full frame readout



TSI Incorporated

Headquarters—Tel: +1 651 490 2811 Toll Free: 1 800 874 2811 E-mail: fluid@tsi.com

UK Tel: +44 1494 459200 E-mail: tsiuk@tsi.com

France Tel: +33 491 95 21 90 E-mail: tsifrance@tsi.com

Germany Tel: +49 241 523030 E-mail: tsigmbh@tsi.com

Sweden Tel: +46 8 595 13230 E-mail: tsiab@tsi.com

India Tel: +91 80 41132470 E-mail: tsi-india@tsi.com

China Tel: +86 10 8260 1595 E-mail: tsibeijing@tsi.com

