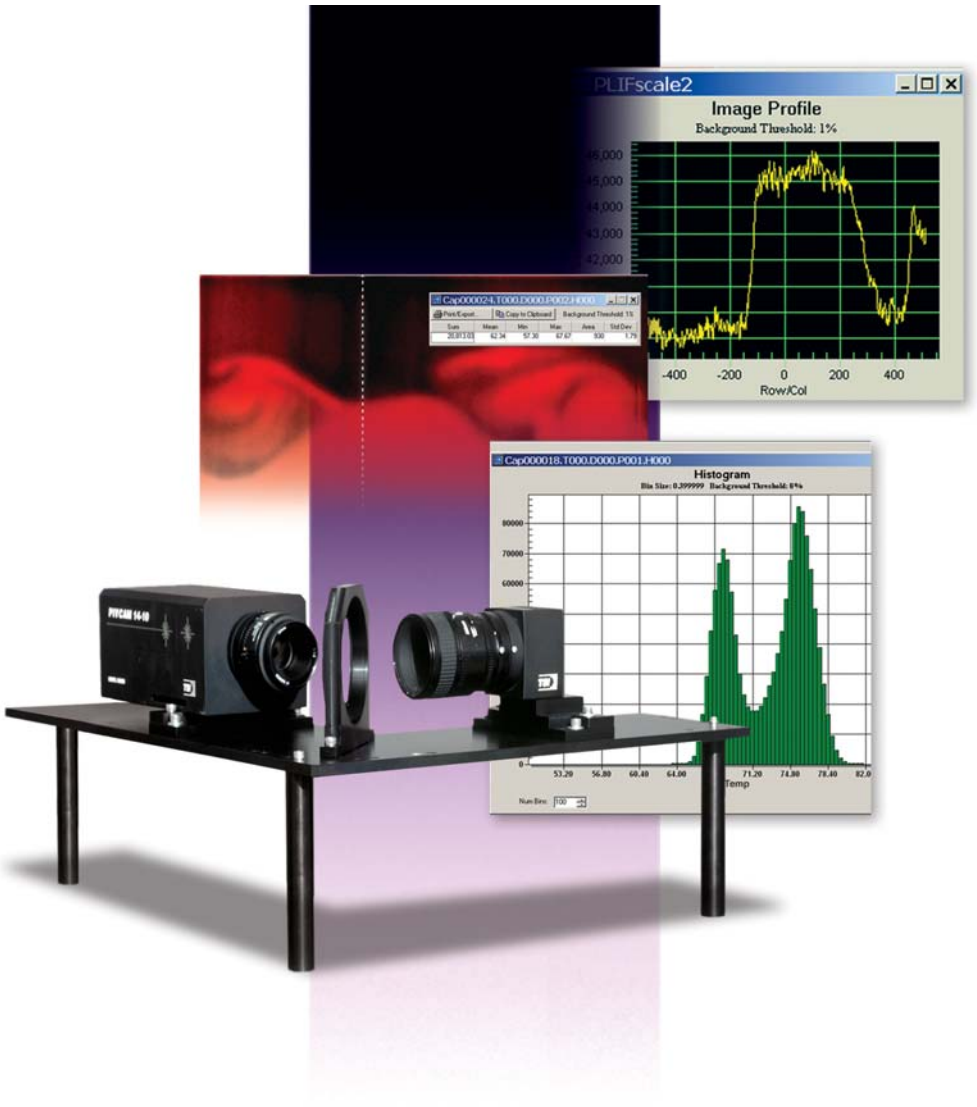
PowerView™ PIV/PLIF Systems

Global Measurement of Flow and Scalar Property Fields



TSI®

Since introducing the first commercial Particle Image Velocimetry (PIV) system in 1988, TSI has led the industry in PIV hardware and software innovation. From optimized StereoPIV to High-frame-rate PIV to MicroPIV Systems, innovation has kept TSI systems unsurpassed in performance and flexibility.

TSI has also done contract development in laser-induced fluorescence for many years, and has now leveraged this experience to develop a powerful, innovative PIV/PLIF (Planar Laser-Induced Fluorescence) system for accurate, global measurements. The integrated PIV/PLIF package is a unique, on-line diagnostic tool that extends the capabilities of a TSI PIV system to simultaneously measure the global scalar property field (e.g., temperature, concentration) along with two or three velocity components.

System Operation

The laser sheet illuminates the measurement region and Mie-scattered light from seed particles, representing fluid velocity, is captured by the PIV camera. Fluorescent emission from the flow medium provides scalar properties such as temperature and concentration. The relationship between the fluorescence intensity and scalar properties, obtained from calibration, is used to convert the PLIF image field into the scalar quantity of interest. On-line image processing, pioneered by TSI, provides the global fields instantaneously. The ability to capture both scalar property and velocity vector fields in a plane enables the user to extract additional information about flow dynamics, interactions and other key mechanisms in the flow.

Laser

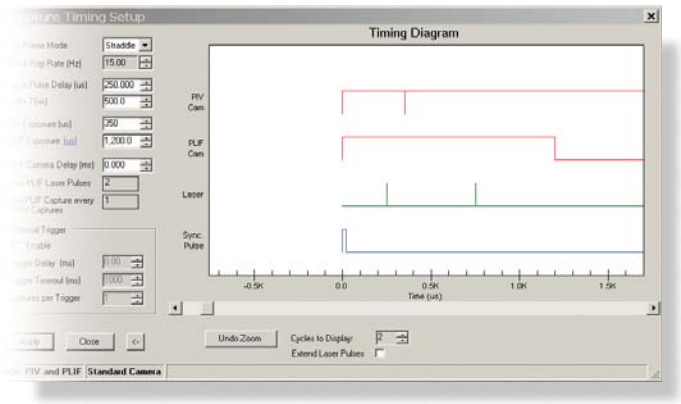
Typically, a YAG laser, due to high pulse energies, high repetition rates, and the availability of harmonics from 532 to 266 nm, is used for PLIF measurements. In cases where additional wavelength agility to excite specific species of interest is needed, TSI offers tunable dye lasers to provide variable output wavelengths and, thus, excitation of a broad range of species for combustion radicals and other reaction intermediates. The tunable dye lasers can be pumped by a YAG laser or, in cases where additional laser energy is needed, excimer lasers can be used.

Cameras

Multi-bit cameras with high sensitivity and low noise are often the cameras of choice for imaging the fluorescence signals in PLIF measurements. TSI PIV/PLIF systems allow the use of different types of cameras for PIV and PLIF imaging. For PLIF applications, a special feature enables the use of long exposure times in order to average the intensity over several laser pulses. This allows integration of the signal in the camera to enhance the signal quality of the camera output. Single-shot measurements are used to examine transient flow structures or time-dependent phenomena. In situations where low light levels are present or very short gate times are necessary, such as in flame or combustion experiments, TSI offers a full range of intensified cameras as well as external intensifiers for upgrading existing cameras, all controlled from a single software platform.

Synchronizer

Hierarchical timing control of all inter-related components is of critical importance to the successful execution of PIV/PLIF experiments. In TSI systems, a graphical user interface with dynamic feedback provides interactive timing control and allows rapid adjustment of laser and camera timings, as well as any external timing control. The external timing control option enables accurate phase-resolved measurements in periodic flows.



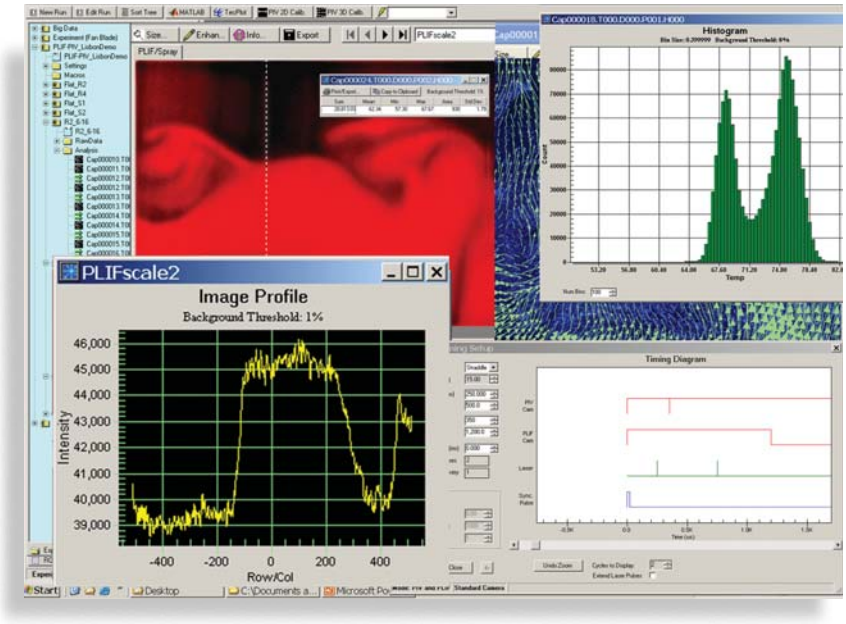
In-situ Calibration

In many PLIF measurements of flames, combustion and engines, the need for a reliable calibration procedure is of critical importance for high quality results. Calibration cell methods may not be suitable for measurements in harsh or otherwise confined environments, such as in IC engines. For this reason, TSI developed a unique, in-situ calibration process for PLIF measure-

Simultaneous or Sequential PIV and PLIF Measurements

With TSI PIV/PLIF systems, the user can make PIV and PLIF measurements simultaneously or sequentially. For simultaneous measurements, a system can be configured with different types of cameras for PIV and PLIF imaging. This allows the user to combine an optimal PIV camera with an optimal PLIF camera, simplifying expansion of an existing global imaging system to make simultaneous measurements of flow and scalar property fields. The unique ***INSIGHT 3G***™ software platform lets the user select PIV, PLIF or simultaneous PIV/PLIF measurement and data analysis.

ments that allows calibration under actual experimental conditions. The in-situ process also corrects PLIF images for spurious background signals, noise, spatial and temporal variability in illumination, and variability in individual pixel response.



INSIGHT 3G Software for Data Analysis and Display

Built on a platform designed for expanding and adding new analysis techniques and hardware, TSI's new ***INSIGHT* 3G** software is the most advanced, most versatile data analysis and display package available for global flow and scalar property measurements. Maximum flexibility is realized through the use of plug-ins whereby users can easily integrate new or custom algorithms for different aspects of the processing scheme.

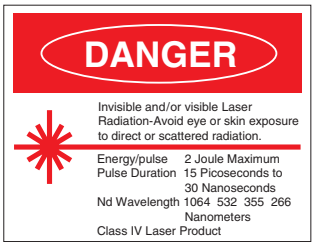
A new interactive tree interface/structure is used for easy data management and processing. Combined with a simple macro set-up that automates image capture, analysis, and validation in batch mode, this fully automates data collection, analysis, and display of results. The software also offers the ability to do PLIF or PIV measurements alone instead of in combination.

Unique frame grabbers capable of fast image transfer allow the user to operate the cameras, including high resolution POWERVIEW cameras, at the highest frame rates with full spatial resolution. This is complemented by a unique mass data storage system that makes it possible to collect and store data from long duration experiments.

Intensity representation using pseudo-color LUT, correction for background and dark noise, image conditioning by removing the background, and AOI for image capture are part of the ***INSIGHT* 3G** software. Dynamic corrections for extraneous background signals, variations in laser illumination, and other noise influences are also built in.

Global Mapping

PLIF measurements in the plane of the light sheet give the spatial variation of scalar properties and associated statistics. Extending this by making global measurements in multiple planes offers a simple, straight forward way to map the evolution and development of these properties. A PLIF system combined with a traverse system provides a systematic way to map scalar property variations. The capability for automatic traversing is built into the ***INSIGHT* 3G** Data Analysis and Display package.



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