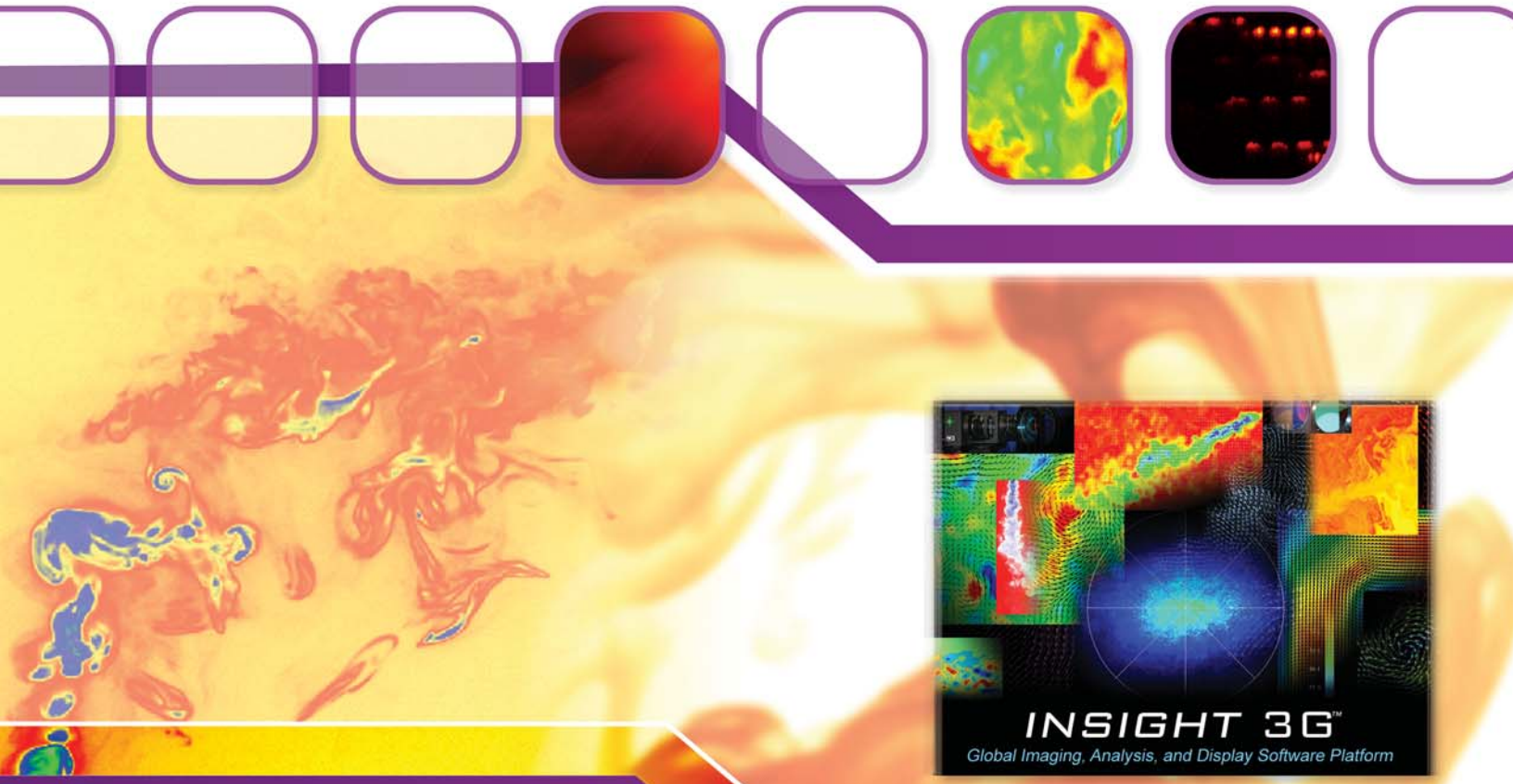
INSIGHT 3G™ – The Most Powerful Global Imaging Software Platform Keeps Getting Better



FLUID MECHANICS

INSIGHT 3G™ Software Platform

TSI™

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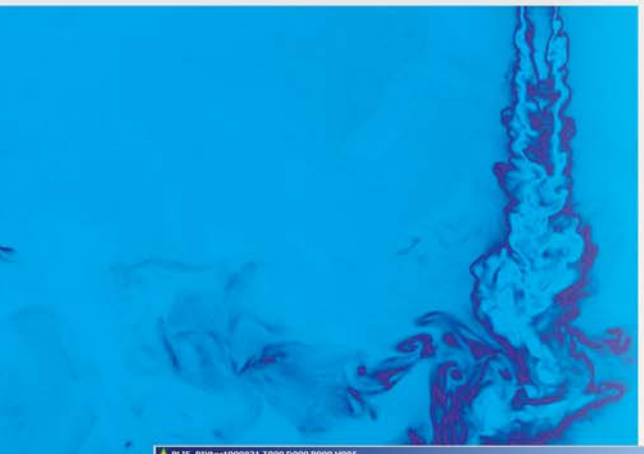
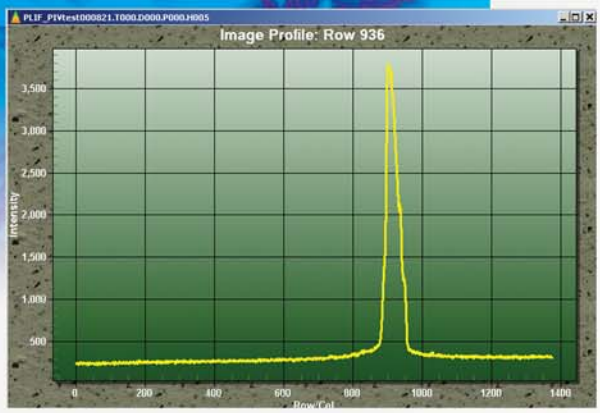
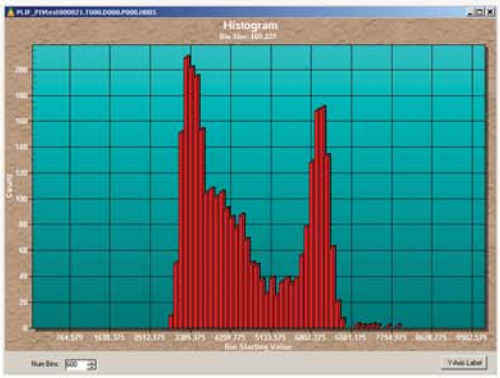
Introduction





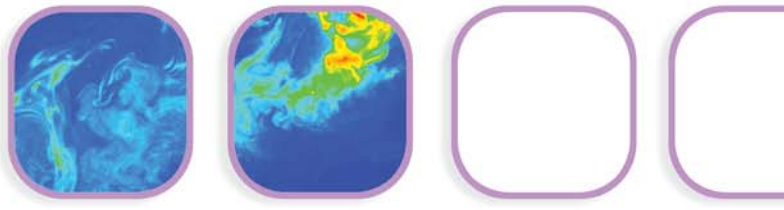


Since its introduction in 2004, ***INSIGHT 3G***™ has completely changed the industry expectations for Global Imaging Software. Because it is built on the latest .Net platform, as opposed to outdated command languages, ***INSIGHT 3G*** is not only the most powerful software platform, it is also the fastest evolving. The third release of ***INSIGHT 3G*** adds significantly to the range of measurement techniques, provides a host of new analysis and image processing tools, and features a new user interface that is both the simplest AND the most powerful available for setting up and executing even the most complex fluid mechanics measurements.

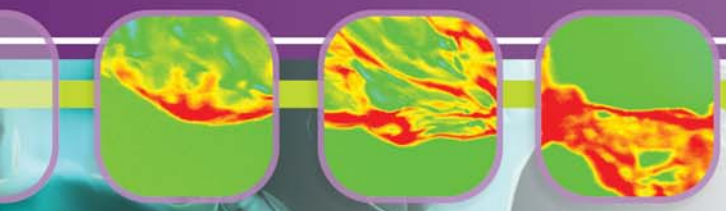
The following pages provide details on many of the key features and capabilities of the new ***INSIGHT 3G*** Software Platform, but there are too many to list all of them here. For more information on how the ***INSIGHT 3G*** Software can help with your measurement needs, contact your local TSI representative. With the largest network of 7 international offices, as well as local representation in a multitude of other countries, and the most expansive customer service, support, and sales team in the industry, TSI is ready to help you.

The Most Advanced Image Analysis Tools

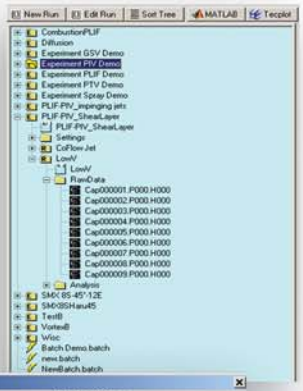
Features	Benefits
Wizard-Guided Algorithm Setup	With the new Processing Pipeline, even complex, multi-step analysis algorithms are set up easily, with an intuitive user interface and complete guidance through every step. There are even call-out buttons to describe each parameter and its role in image processing and analysis.
Complete Hardware Control	Simplifies system operation; all hardware can be simultaneously operated with a single button push, even for multiple simultaneous measurements.
Simple Expansion	As your measurement needs continue to evolve, INSIGHT 3G will be there, with simple upgrades to expand to new measurement capabilities in the future, often without the need for expensive new hardware.
Amazing Flexibility	Unique, user-defined algorithms of arbitrary complexity and number of steps can be easily defined using the incredible range of image mathematics and processing tools, including linear and nonlinear filters, image arithmetic, complex image masking, binning, and many others.
Print Quality Graphics	Allows you to go directly from image capture and image processing to print-quality graphs and plots that can be exported (in a range of formats) directly into reports and publications.
Additional Capabilities	Provides links to TecPlot® and MATLAB® packages for enhanced graphical presentation and additional analysis of your data.

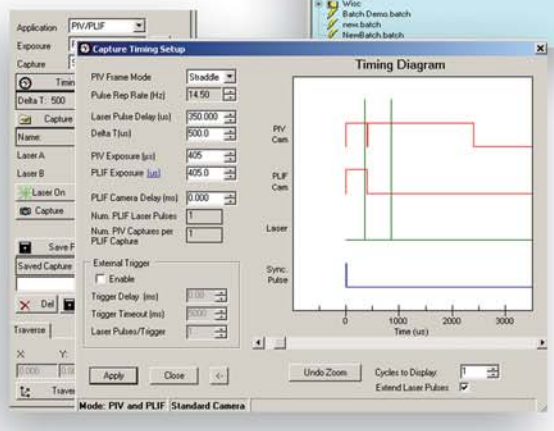


The Processing



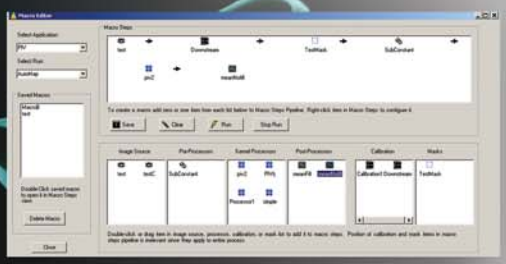
Intuitive experimental data directory

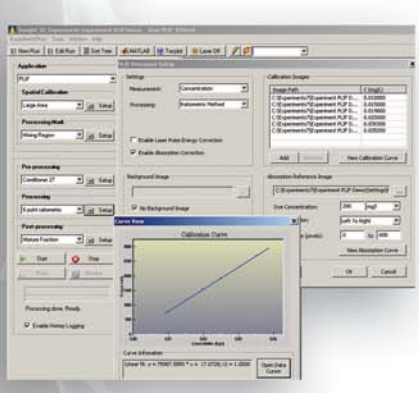




Simple, interactive setup of hardware operation

Graphical, icon-driven Visual Macro Programmer simplifies processing setup



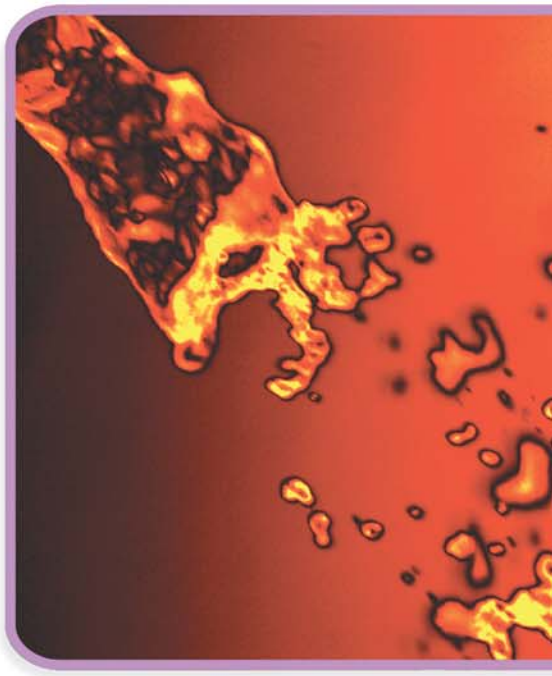


The processing pipeline guides you through each step, the perfect combination of power, flexibility, and customization

Pipeline

The extensive measurement capabilities of the *INSIGHT 3G* package derive from the broad range of supported measurement techniques, including:

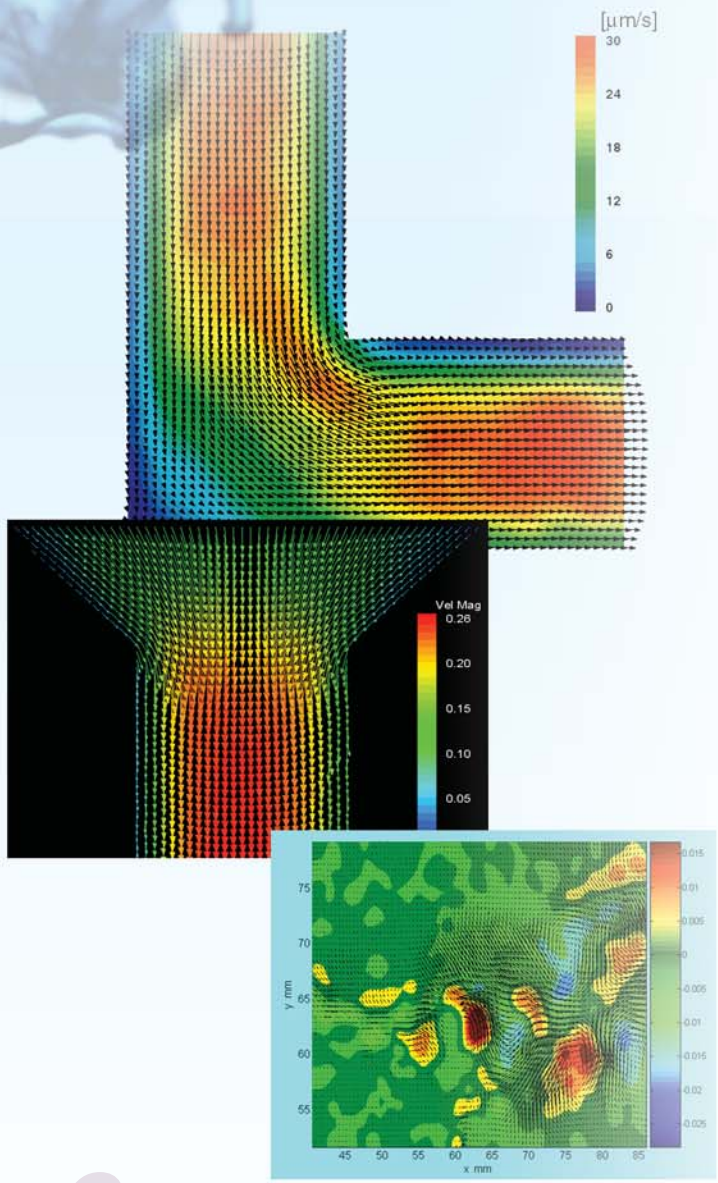
- Particle Image Velocimetry (PIV), including
  - Micron-Resolution PIV
  - Stereoscopic PIV
  - Time-Resolved PIV
- Planar Laser-Induced Fluorescence (PLIF)
- Global Sizing and Velocimetry (GSV)
- Particle Tracking Velocimetry (PTV)
- Super Resolution Particle Velocimetry (SRPV)
- Direct Image Size-Shape Analysis
- Time-Resolved High Speed Imaging
- Patternation and Spray Analysis



The *INSIGHT 3G* software platform is the most powerful environment available for performing global imaging measurements of single- and multi-phase fluid flow properties. Measurement capabilities include:

- Global fluid velocity field in liquid or gaseous flows
- Global displacement field in solids
- Global scalar field (concentration, temperature) in liquid or gaseous flows
- Simultaneous droplet size/velocity in sprays
- Fluid phase velocity field in accessible multiphase flows
- Combustion species measurements (including OH, CH, NO, CO, among many others)
- Flame front geometry
- Time-resolved, high speed imaging and analysis
- Rayleigh scattering imaging
- Raman scattering imaging
- LII imaging

Particle Velocimetry



INSIGHT 3G features the widest range of particle velocimetry measurements available, including:

Particle Image Velocimetry (PIV)
- Micron Resolution PIV (mPIV)
- Time Resolved PIV (TR-PIV)
- Stereoscopic (Stereo-PIV)

Particle Tracking Velocimetry (PTV)

Super Resolution Particle Velocimetry (SRPV)

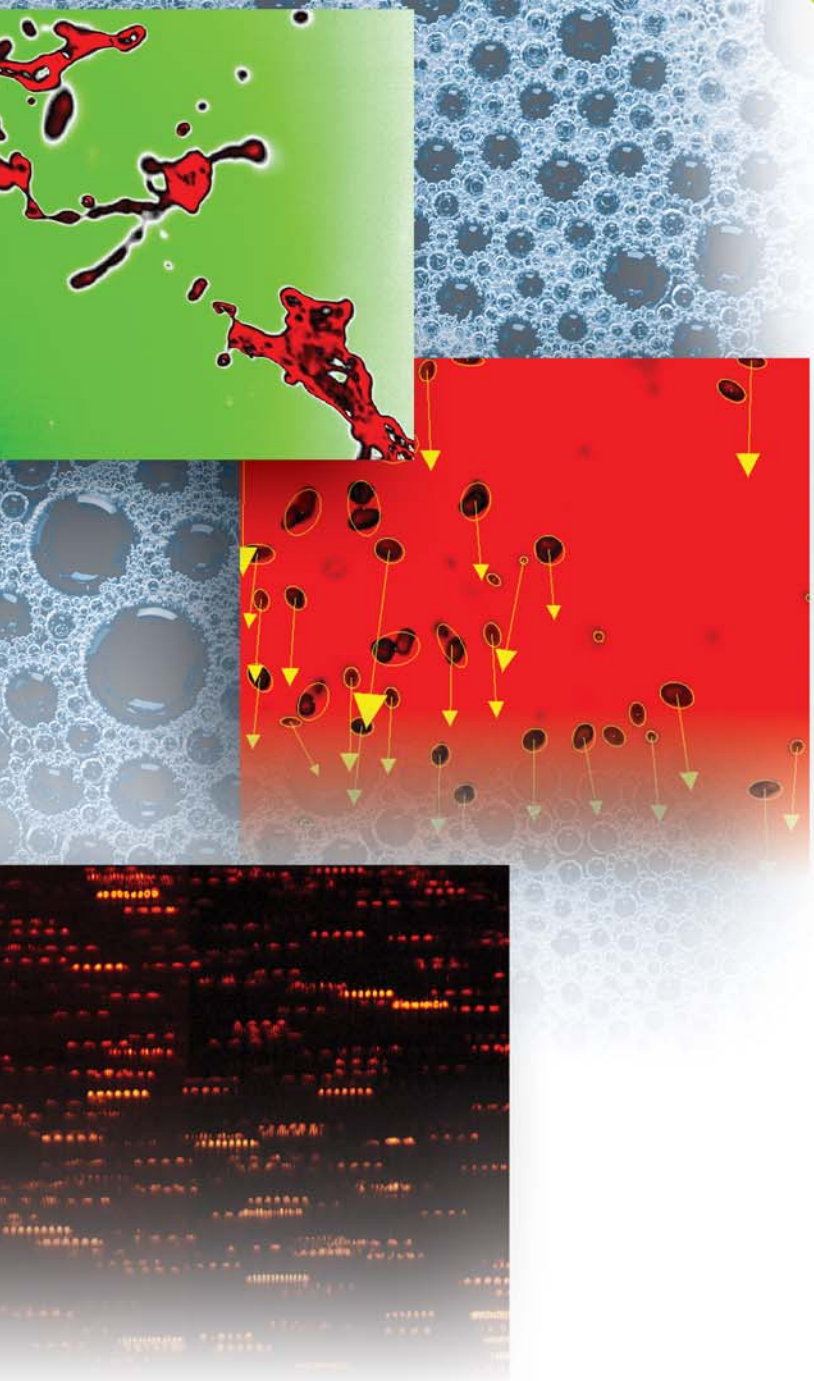
All particle velocimetry methods use the motion of small tracer particles to quantify the velocity field of the fluid. Innovative algorithm design and a comprehensive range of image pre-processing, processing, analysis, and display options are critical for accurate velocity measurements in the full range of potential applications. The *INSIGHT* 3G Software Platform incorporates more patented concepts than all competitive systems combined.

The processing algorithms are defined using the processing pipeline, a step-by-step, wizard-guided user interface that is not only simple to use, but also provides a complete range of image processing tools. The icon driven macro-programmer allows drag-and-drop creation of an entire measurement sequence, from image capture through processing and analysis, and it can all be executed with a single mouse click.

Measurements

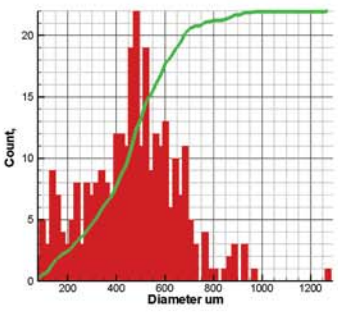
Features	Benefits
Proper Orthogonal Decomposition (POD) Toolbox	POD is the most advanced tool for characterizing and quantifying the flowfield properties from a sequence of PIV velocity vector fields. The built-in toolbox provides rapid, simple setup and execution of the POD processing, with multiple display and analysis options.
Spectral Analysis of Time-Resolved Data	A built-in tool box is also provided for spectral analysis of time-resolved PIV velocity vector data, providing quantification of the frequency content of the flowfield.
HyperStreaming	HyperStreaming allows the direct transfer of images to the computer at the FULL CAMERA FRAME RATE, with storage capacities of several terabytes.
StereoAutomapping	StereoAutomapping corrects for misalignment between the calibration target and laser light sheet in stereoscopic measurements. With the wizard-guided setup, StereoAutomapping is not only the most advanced method available for correcting to this potential source of error, but is also the easiest to implement and execute.
Widest Range of Image Processing and Correlation Algorithms	***INSIGHT* 3G** is the only Global Imaging Software platform with patented PIV processing algorithms, including the Hart Correlation and Rohaly-Hart Analysis, and also features advanced processing algorithms such as multi-pass image deformation processing, FFT correlation, and Direct correlation, with full user control of all processing parameters.
Extensive Image Pre-processing Capability	***INSIGHT* 3G** is equipped with essentially limitless image pre-processing capabilities, with a full range of image arithmetic, de-warping, averaging, masking and filtering algorithms. With simple setup in the Processing Pipeline, multiple operations can easily be set up and executed. In many applications, image pre-processing is critical for obtaining high quality velocity field measurements.

Multiphase Flow



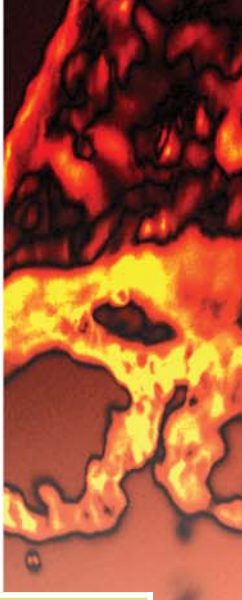
The *INSIGHT* 3G Global Imaging Software Platform incorporates a comprehensive assortment of image processing and analysis algorithms for quantitative evaluation of a broad range of multiphase flow phenomena, featuring the most advanced techniques available for separating individual phases in the flow, and thus providing detailed analysis of the flow properties of the independent phases. Including bubbling flows, granular flows, as well as liquid-liquid and particle laden flows, the *INSIGHT* 3G software includes all required tools for quantitative analysis of the multiphase flow properties.

Analysis of multiphase flows requires specialized hardware and software capabilities in order to accurately measure the desired flow properties. Illumination sources vary from planar laser illumination to volumetric back-illumination, depending upon both the flow and the measurement objectives. Similarly, imaging requirements dictate high resolution rendering of the displacement field. *INSIGHT* 3G offers complete control of all hardware components, including illumination sources such as lasers and strobe lights, as well as scientific grade digital cameras, with simple, interactive setup and single-button activation for the entire measurement sequence.

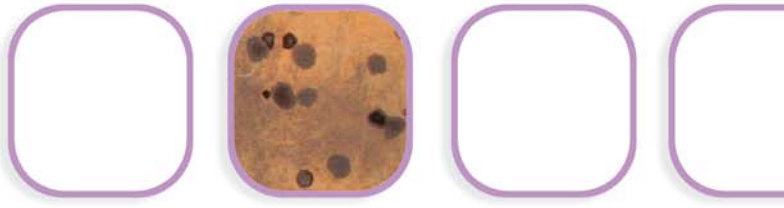


Multiphase Flow Analysis

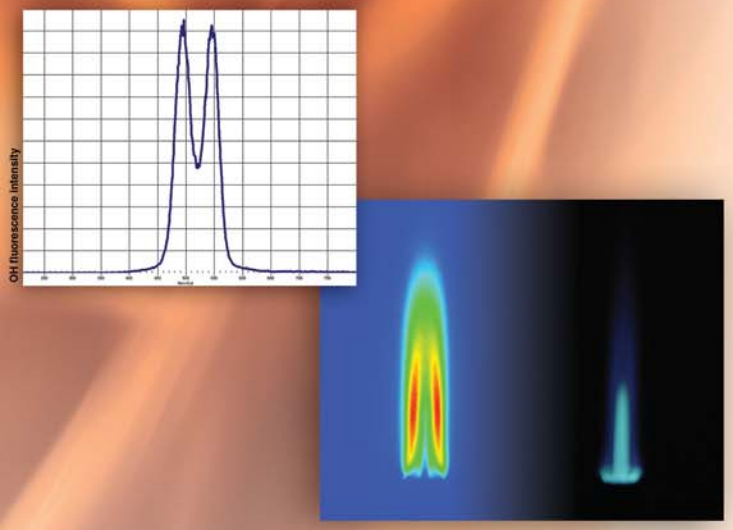
Measurements



Features	Benefits
Size – Shape – Velocity Analysis of the Dispersed Phase	The dispersed phase 'objects' (particles, droplets, bubbles, etc.) can be analyzed to evaluate a range of properties. In addition to the object velocity, INSIGHT 3G also measures a host of size and shape parameters, including the mean diameter, the minimum and maximum diameter (ellipticity), ellipse angle, Feret diameter, area, and perimeter.
Numerous Computational Methods for Phase Separation	INSIGHT 3G provides multiple tools for separating and measuring independent flow properties in the different phases, including intensity separation, dynamic image masking, image filtering, and fluorescence methods. Successful separation of the different phases is critical for quantitative analysis of the flow properties of the individual phases, rather than the mean properties of both phases together.
Simultaneous Droplet Size – Velocity Measurements, with a Single Camera	Global Sizing and Velocimetry (GSV) is an interferometric sizing technique that incorporates patented algorithms, and unique camera slit arrangement, and a novel viewing angle that eliminates the influence of changes in refractive index to provide the highest accuracy imaging measurements of droplet size and velocity in sprays. The camera slit arrangement reduces the size of the interference pattern image by more than 80%, allowing for measurements in higher density sprays than other interferometric imaging techniques.
Spray patternation and analysis	Automated algorithms have been implemented to allow rapid measurement of numerous spray parameters such as the global pattern factor (a measure of the symmetry and repeatability of the spray), along with the cone angle and penetration depth. The pattern factor analysis can be performed in a ring or sector geometry, with user controls of the number of rings/sectors. These features make the spray analysis simultaneously simple to setup and use, extremely flexible, and comprehensively powerful.

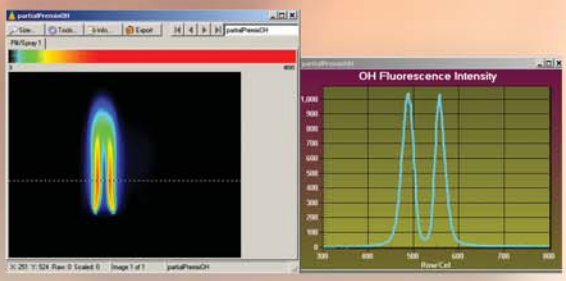


Global Scalar

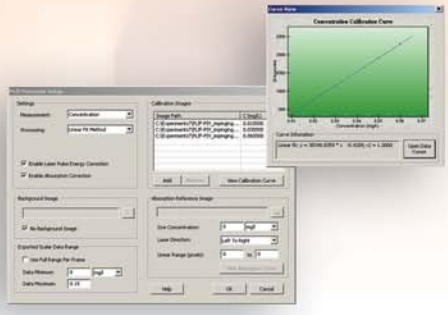


The most common Global Scalar Measurement is planar laser-induced fluorescence (PLIF). Measured parameters include:

- concentration and temperature fields in the fluid
- fluid mixing and mixture fraction
- combustion species and radical distributions
- fuel mixing, distribution, and concentration
- flame front propagation and geometry



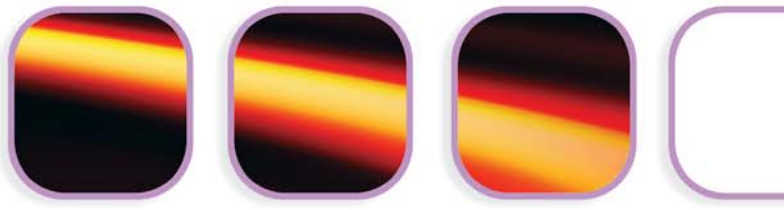
The specific hardware and software requirements for PLIF measurements depend upon the application. For liquid PLIF measurements, a 532 nm Nd:YAG laser is typically used to measure concentration, temperature, or mixing properties in the fluid. In gaseous PLIF applications, UV wavelengths are typically required (via the 266 nm YAG harmonic, or through a wavelength tunable system) and intensified cameras are sometimes needed. In combustion species measurements, a wavelength tunable dye laser system and intensified camera are generally required. ***INSIGHT 3G*** provides full support and control for all PLIF hardware options, with simple integration and operation for rapid setup and measurement execution.

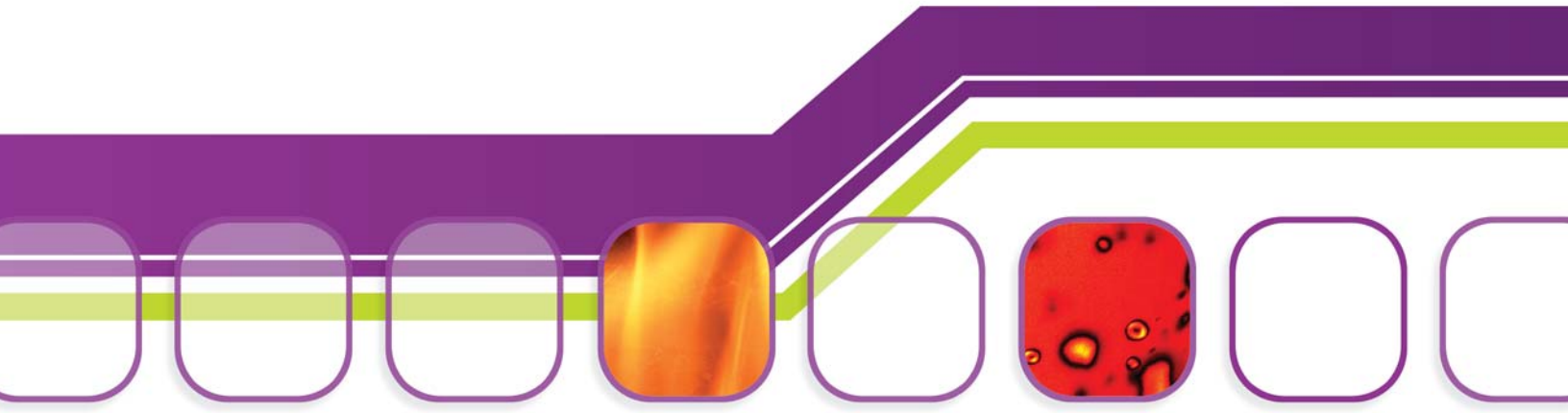


In order to gather quantitative information from fluorescence images, there are a number of potential error sources that must be considered and corrected for. ***INSIGHT 3G*** has a complete range of algorithms to account for influences such as spatial variations in laser light sheet intensity, pulse-to-pulse energy fluctuations, laser attenuation, background reflections and noise, and variations in individual pixel response. All correction factors are applied individually to each and every pixel in the image field. In addition, ***INSIGHT 3G*** features a complete spectrum of image processing, display, and analysis tools. The processing pipeline allows rapid, simple setup of the entire experimental procedure, from image capture through processing, analysis and display, executing all operations with a single mouse click, even in complex or unique measurement situations.

Measurements

Features	Benefits
Multipoint image processing	Multipoint processing improves the accuracy of scalar measurements by accounting for non-linearity in the fluorescence signal, as occurs when moving from the linear into the saturated fluorescence regime. In measurement situations where fluorescence in the linear regime is required, multipoint calibration is also used to quantify the extent of the linear regime.
Linear curve fit or ratiometric image processing	Both linear curve fitting and ratiometric interpolation/extrapolation using the two nearest calibration points can be implemented with the multipoint image processing, providing additional flexibility as measurement requirements dictate.
Attenuation corrections	In combination with TSI's collimated light sheet generator, INSIGHT 3G features built-in algorithms to correct for laser attenuation as light traverses the absorbing fluorescent species in the flow, improving measurement accuracy throughout the measurement region.
Dynamic link to Matlab	Automatic controls are provided for transferring data into and out of Matlab, allowing simple implementation of user-defined processing algorithms and code. Execution of the code and all data handling is controlled by INSIGHT 3G.
Complete range of hardware options	Includes wavelength tunable dye laser and other wavelength solutions, a full range of intensified and un-intensified cameras, collimated light sheet generators, fluorescent tracer species for liquid flows, as well as laser light sheet and camera filter optics, for maximum experimental flexibility.
Advanced image analysis and display options	Scalar data can be combined with velocity vector data for analysis of higher order quantities such as mass flux and heat flux. Display options provide complete control over the display and appearance of image data, which is especially important for highlighting important features in scalar PLIF data.
Laser pulse energy correction	Allows measurement of the pulse energy, which allows correction for errors in scalar data related to pulse-to-pulse energy variations in the laser.





TSI Incorporated serves a global market by investigating, identifying and solving measurement problems. As an industry leader in the design and production of precision instruments, TSI partners with research institutions and customers around the world to set the standard for measurements relating to aerosol science, air flow, indoor air quality, fluid dynamics and biohazard detection. With headquarters based in the U.S. and field offices throughout Europe and Asia, TSI has established a worldwide presence in the markets we serve. Every day, our dedicated employees turn research into reality.

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