Gemini PIV and Solo PIV Nd:YAG Laser Systems

PRODUCT OVERVIEW

Solo PIV and Gemini PIV are compact, dual-head laser systems designed specifically to provide highly stable green or UV light for Particle Image Velocimetry (PIV) experiments. Both systems feature an external TTL interface, and are available with an optional motorized optical attenuator that preserves pulse-to-pulse stability at low energy settings.

Gemini is a compact, dual-power supply, dual-head laser system designed for higher-speed liquid and air flow PIV applications and those requiring a larger interrogation area. Solo is designed for water flow and some low-speed air flow applications. It offers the advantages of a single umbilical, a single compact power supply for easy setup and movement, and a single control panel for ease-of-operation.

Gemini PIV

Solo PIV

About New Wave Research

New Wave Research designs, manufactures and markets compact high-performance Nd:YAG laser systems. The company applies its extensive experience in pulsed, solid-state lasers, optics and beam delivery systems to bring these products to the industrial, scientific and OEM markets.

NEW WAVE RESEARCH

Features and Benefits of Gemini and Solo PIV Lasers

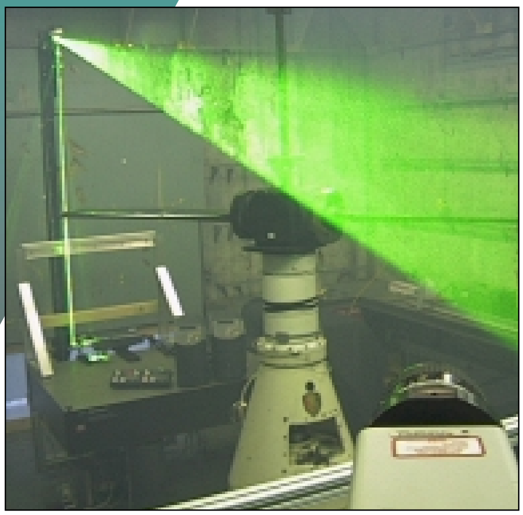
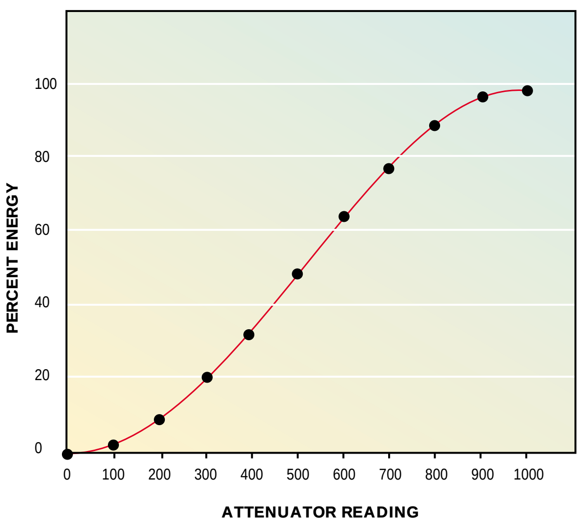
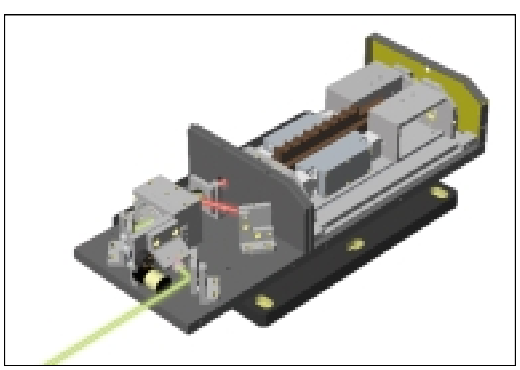


Photo courtesy of NASA Ames

Gemini laser producing light sheet for PIV air flow experiment.



Laser output vs. attenuator reading.



Configuration of a standard Solo PIV.

COMPACTNESS

- A single, small power supply powers dual Solo PIV laser heads for easy setup, simplified operation and minimal space.
- Separate compact Gemini power supplies, one for each laser head, fit easily under an optical bench or PIV experiment setup.
- All PIV heads are compact making them easy to transport to different PIV experiments and to arrange in horizontal or vertical orientations.

EASE-OF-USE

- Each Gemini PIV unit has an individual control panel, connected to a dedicated power supply by a 8 ft. (2.4m) umbilical, providing safe, simple control of all laser system functions.
- All Solo PIV laser functions can be controlled from the power supply panel.
- Single-phase, 115/230 VAC power and internal, closed-loop cooling facilitate setup and operation.
- Intuitive controls and ergonomic design simplify operation and maintenance, increasing user productivity.
- Optional motor-controlled half-wave plate and polarizer combine to attenuate the energy without affecting beam quality. Optical losses due to the attenuator will reduce maximum energy by 10%. The graph to the left shows transmitted energy as a function of the attenuator reading.

RELIABLE OPERATION

- Thermally compensated resonator assures stable operation.
- Requires minimal maintenance, increasing system up-time.
- Field-proven reliability permits users to concentrate on their applications, rather than on system upkeep.

EXCEPTIONAL PERFORMANCE

- Superior, proven design provides stable, high-energy output with excellent beam quality and pulse-to-pulse stability.
- Compact resonator design provides excellent beam pointing and energy stability.
- Predictable, high performance ensures that your work gets done faster.

APPLICATION FLEXIBILITY

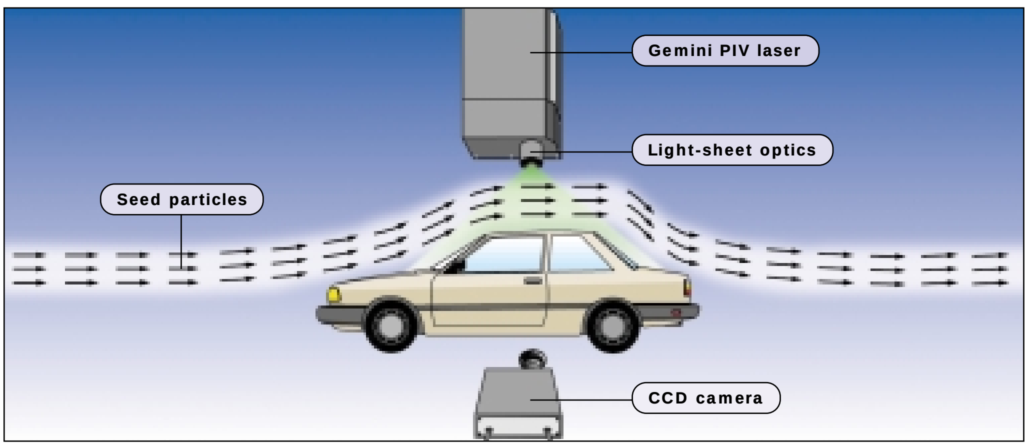
- Repetition rates of 15 Hz and 30 Hz synchronize with CCD imaging systems.
- Separate flashlamp and Q-switch control with TTL pulse triggering allows variable delay between laser pulses with low jitter and consistently high beam quality.
- Custom configurations, such as 355 or 266 nm UV energy, orthogonally polarized pulses and dual outputs for two-color PIV, are available to further increase application flexibility.

The Concept of Particle Image Velocimetry

Particle Image Velocimetry (PIV) is a powerful fluid dynamics technique that provides detailed information on velocity flow in complex systems. Three dimensionality, turbulence, shear flow and multi-phase flow are a few examples of the applicability of PIV.

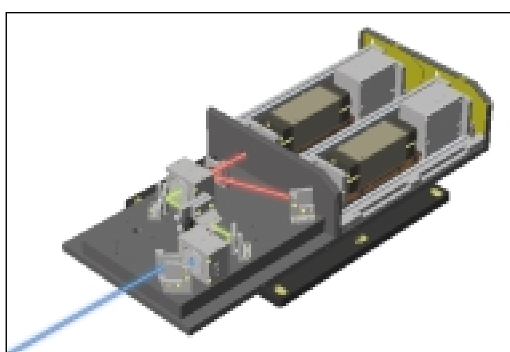
The PIV process involves seeding the fluid flow with particles that scatter light. The region of interest is illuminated with a light sheet created by a frequency-doubled, pulsed Nd:YAG laser. A CCD camera captures the image created by the scattered light. A light sheet from a delayed second laser pulse, creates a second image that is captured by the subsequent CCD camera frame. The two images are compared using cross-correlation techniques to generate a velocity vector field. Analyzing multiple images provides quantitative information on temporal and spatial flow behavior.

SCHEMATIC LAYOUT OF TYPICAL PIV EXPERIMENT

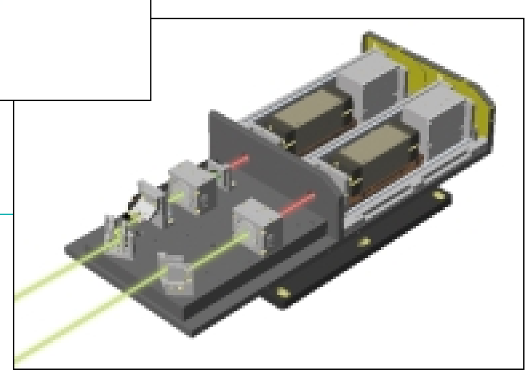


GEMINI AND SOLO PIV HEAD DESCRIPTION

Two 1064 nm laser heads are mounted on a single baseplate. The infrared beams generated by these laser heads are polarization combined. They enter a second-harmonic generator to produce vertically polarized green (532 nm) laser pulses. The output of the second-harmonic generator hits dichroic mirrors which transmit the residual 1064 nm energy to metal absorbers and reflect the 532 nm green energy out of the laser exit port. The temporally separated green laser pulses are aligned so the beams are spatially overlapped to allow precise determination of flow velocity vectors in the PIV experiment.



Custom Gemini PIV configuration for UV (266 nm) illumination.

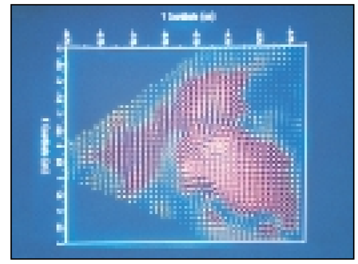


Custom Gemini PIV configuration for two-color PIV. One 532 nm beam pumps a tunable source to generate the second color.

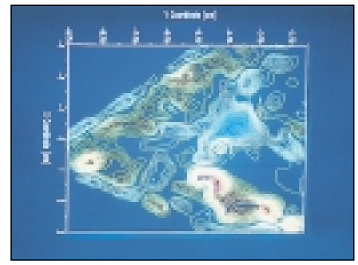
CARDIAC FLOW RESEARCH

One of the remarkable achievements of quantitative visualization in recent years has been in the area of characterization of intracardiac flows. It presents a complex fluid mechanical system, the understanding of which is crucial in cardiac flow diagnosis and the treatment of its deficiencies. The Cardiovascular Fluid Dynamics Research Laboratory at the California Institute of Technology quantitatively visualized the impact of different transmitral flow morphologies on left ventricular filling characteristics when different valvular prostheses were used under in-vitro pseudo-physiological conditions. The upper image to the right shows the vector velocity field of the transmitral flow associated with a bioprosthetic mitral valve inducing a centrally directed flow with a vortical structure. The lower image to the right demonstrates a vorticity field of the velocity vector field shown in the upper figure. These images were captured using the Digital PIV technique with a 25 mJ, double-pulsed New Wave Research PIV Nd:YAG laser system.

Edmond Rambod and Mory Gharib, California Institute of Technology.



Vector velocity field of the transmitral flow associated with a bioprosthetic mitral valve.



Vorticity field of the velocity vector field from the above figure.

MICRO-RESOLUTION PIV

A novel PIV technique measures flow fields in micro-fabricated fluidic devices. This technique extends the spatial resolution of conventional PIV techniques from about 100 microns down to the one micron range.

In the current research, velocity measurements are made by tracking the images of groups of ~100 nm diameter particles. A large enough particle size is chosen so that Brownian motion of the particles does not contribute appreciably to errors in the velocity measurements. Also, small enough particles are chosen so that the particles follow the flow faithfully, do not alter the flow field, and do not plug the micro device. Images of the particles are captured and digitized with a large-format, high-dynamic range CCD camera. The resulting image fields are statistically analyzed to determine the most probable particle velocity, which is also the best estimate of the local fluid velocity. Velocity measurements of thousands of particle images are captured and measured in a two dimensional plane at one instant in time. The figure to the right shows the results of this procedure.

Steve Wereley, Juan Santiago and Carl Meinhart, University of California, Santa Barbara.

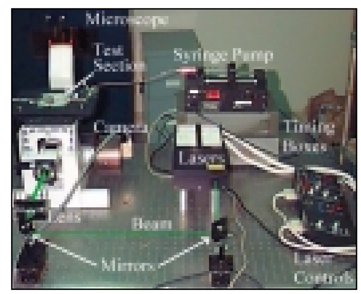
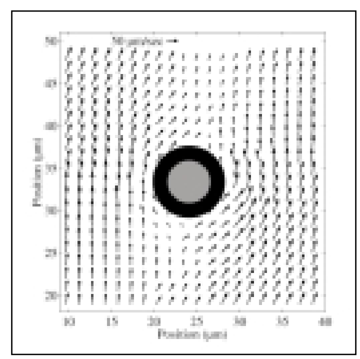


Photo of experimental apparatus.



Velocity flow vector field around an 8 micron diameter blood cell.

VISIBLE AND INVISIBLE LASER RADIATION. AVOID EYE AND SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION.
Wavelength 1064nm/600 mJ/5ns
Wavelength 532nm/500 mJ/5ns
Wavelength 355nm/300 mJ/4ns
Wavelength 266nm/200 mJ/4ns
Wavelength 213nm/100 mJ/4ns
Wavelength 670nm/5mW
CLASS 4 LASER PRODUCT

NEW WAVE RESEARCH

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