

High-Speed PIV Laser and CMOS Camera Technology Proves Optimal in Fast-fluid, Dynamic-Event Studies

Researchers at Florida State University tap high-speed PIV to gain greater understanding of jet-flame combustion process.

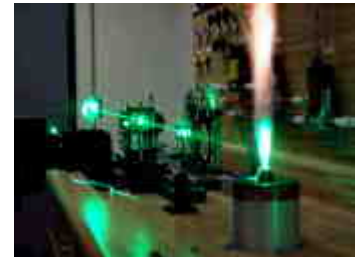
Researchers at the Florida State University Combustion Laboratory are hard-at-work unlocking the secrets of jet-flame burner combustion. How can BTU output be maximized within a given space and burner geometry? How can the combustion process be made more efficient – yielding lower fuel consumption, operating costs and pollutants? To answer these questions, FSU's researchers have exploited a powerful, new research technology: high-speed PIV.

Because the combustion process is not uniform in time and space, a high-speed PIV system is ideally suited for studying instabilities in the flame. Its ability to provide exceptional resolution of fast-fluid dynamic events enables researchers to accurately study the flame front, the dynamics of the flame where the chemical reaction takes place and the effects of varying the fuel-air mixture and burner geometry.

Conventional PIV techniques are limited to time resolution of about 15 camera frames per second. Much of the combustion process occurs between camera frames and cannot be characterized at this speed. A higher-speed camera and light source (thousands of frames per second) enables a much higher time-resolved study of the combustion process. Until several months ago, this higher-speed resolution was not possible because the cameras and light sources were not available.

FSU's PIV system consists of the New Wave Research Pegasus-PIV, a laser designed for high-speed PIV, the X-Stream, XS-3 high-speed CCD camera from IDT and PIV software, also from IDT.

The combustion experiment consists of 20 sets of conditions; each experiment produces approximately 200 images that characterize the combustion process. The Pegasus beam is mildly focused into a cylindrical lens placed about one meter from the flame to create the light sheet (see photos). To illuminate the flame for PIV, it is seeded with Al_2O_3 particles that follow the flame flow and reflect laser light, enabling the camera to record the flame flow. The flame appears green in the area where the laser beam passes through the flame. The flame is a propane/air mixture of about 1:1 and has a flow rate of 7 to 8 meters per second. The laser repetition rate is 150 – 4500 pulses per second for each laser head (300 – 9000 pulses per second for both laser heads combined). The camera frame rate is 300-4500 frames per second.



Light sheet passing through the flame.



Aluminum Oxide particles give flame a green appearance where the laser beam passes through flame.



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PIV Lasers Available from New Wave Research

Applications	Model	E @ 532 nm	E @ 266 nm	Rate
Micro and Water Flow PIV	Solo I PIV 15	15 mJ	NA	15 Hz x 2
	Solo II PIV 15	30 mJ	NA	15 Hz x 2
	Solo II PIV 30	30 mJ	NA	30 Hz x 2
	Solo III PIV 15	50 mJ	NA	15 Hz x 2
	Solo IV PIV	50 mJ	NA	50 Hz x 2
Water and Air Flow PIV	Solo PIV 120	120 mJ	25 mJ	15 Hz x 2
	Gemini PIV 90	90 mJ	15 mJ	30 Hz x 2
Air Flow PIV	Gemini PIV 200	200 mJ	40 mJ	15 Hz x 2
High-Speed Air and Water Flow PIV	Pegasus-PIV	10 mJ	NA	1 Hz—10 Hz x 2

* Whether your application is MicroPIV, water, or air flow, New Wave Research has a full range of laser systems from which to select. Laser selection depends on the size of the interrogation area, seeding, and the medium of the experiment.



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