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RECENT DEVELOPMENTS IN OPTICAL DIAGNOSTICS SPRAYS AND COMBUSTION

Fuel sprays are still the mainstream industrial application for introducing fuel into combustion chambers in jet engines. With the advances in the laser technology, optical diagnostics has become the key tool for research in aviation engines. Today, it is possible to deliver very coherent, spectrally pure, constant intensity beam into the measurement volume. Regardless of the technique used, these properties of laser light allows for a controlled input to the experiment thereby providing an accuracy value often limited by the laser wavelength.

The point measurements of velocity, particle size and temperature utilize the LDA, PDA and Dual-band LIF techniques respectively. Because PDA and LIF hardware can be an extension of the LDA system, the simultaneous measurements of velocity, droplet size and temperature is possible. While point measurements provide sufficient accuracy and spatial resolution, often the global behaviour of the process is of interest. For this purpose, the laser beam is stretched into a thin sheet to illuminate a planar measurement area. In such planar measurements, often a high-quantum efficiency camera is used, thus the planar measurement techniques are also called the imaging techniques. These include Interferometric Particle Imaging (IPI), Shadow sizing and Spray geometry for droplet size and spray shape measurements and Particle Image Velocimetry (PIV) and Particle Tracking Velocimetry (PTV) for velocity measurements.

PIV has matured over a quarter century and is now an established tool in fluid diagnostics. The development of the technique has been tremendous due to relentless advances in laser, detector, and CPU processor technology: In 25 years, the technique evolved from the manual construction of a 2-component velocity field from a double-exposed particle image on a single photographic paper, to digital storage and computation of 3-component velocity fields in liter-sized volumes in a time resolved fashion. Along the way, several other sub-techniques and names, such as Digital-PIV, Micro-PIV, Nano-PIV, Holo-PIV, Stereo-PIV, Endoscopic-PIV have been introduced to describe certain variations of the technique.

With the availability of high-power-, high-repetition rate lasers and high-speed cameras the laser beam can be expanded to illuminate a 3-D volume for volumetric velocity measurements. This means, the measurement of unsteady, inertial and viscous terms of the Navier-Stokes equation is possible using time resolved volumetric velocimetry, allowing the estimation of the volumetric pressure distribution in the measurement volume. Application examples and corresponding results will follow the presentation of each technique.