"A Technique for Routine, Cycle-Resolved 2-D Flow Measurement and Visualisation within SI Engine Cylinders in an Engine Development Environment"

by

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ABSTRACT

A high speed digital Particle Image Velocimetry system has been developed that provides combined real time flow visualisation and rapidly processed PIV data in an industrial optical research engine facility. The system is based on commercially available, high speed imaging and laser technology and conventional digital cross-correlation processing to provide cycle-resolved PIV data and flow visualisation within timescales appropriate for engine development. Measurements are reported at an engine crank rotation speed of 700 RPM, with an image rate of 9000 frames per second. This allows a PIV velocity map to be generated approximately every 0.5 degree crank angle, allowing the full time history of the flowfield at a single planar location to be determined throughout a complete engine cycle. A simple variation on the synchronisation scheme also allows the acquisition of tens to thousands of flow visualisation sequences and PIV maps at the same crank angle in every successive engine cycle, thereby enabling the study of cycle-to-cycle flow variability. This has allowed the spatial regions responsible for highest velocity field variability to be located in a realistic geometry research engine. The rapid turnaround rate for the optical engine and data processing has lead to this technique being adopted for routine in-cylinder flowfield analysis and validation of CFD predictions. The technique may also find applications in other unsteady or oscillatory flows of importance in aerodynamics, combustion, acoustics, mixing, and heat transfer.
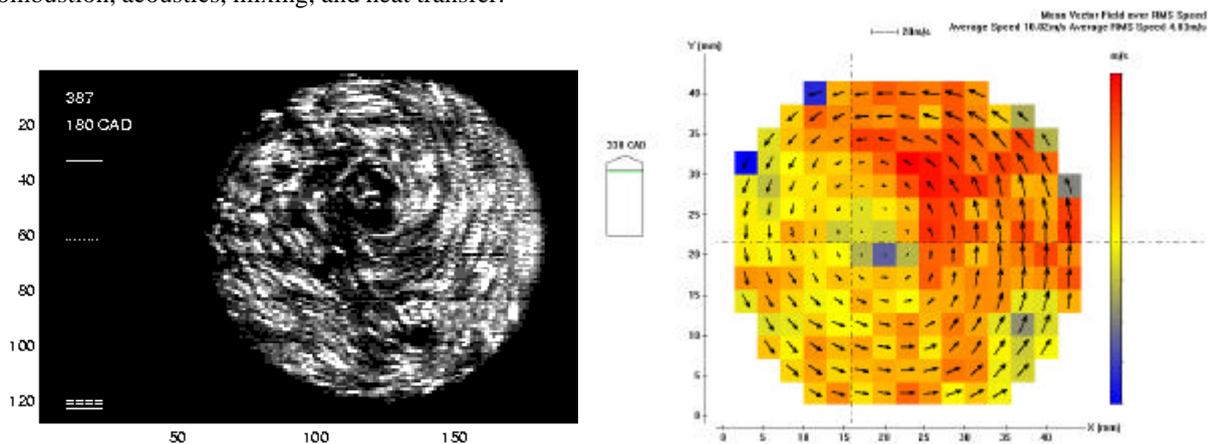
Figure 1. Typical instantaneous Flow Visualisation image and PIV plot showing Mean velocity (arrows) and RMS variability (background) as a function of position.