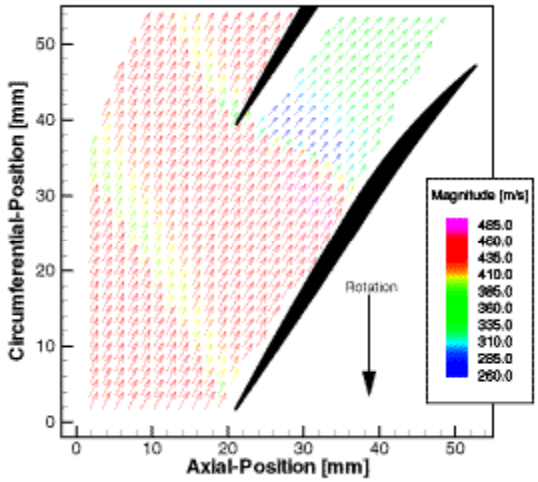
Particle Imaging Velocimetry Used in a Transonic Compressor Facility

Particle Imaging Velocimetry (PIV) is an optical technique whereby a pulsed laser sheet is used to illuminate particles entrained in a fluid across an extended planar cross section of a flow field. Electronic recording of the particle positions at two closely timed laser pulses permits the computation of the flow velocity. PIV captures the instantaneous flow field, permitting the study of unsteady flow phenomena. Mean flow statistics can be computed by acquiring several hundred images and averaging the results.

The first-ever successful application of PIV to acquire measurements in a high-speed rotating turbomachinery blade row was completed in NASA Lewis Research Center's W-8 Single Stage Axial Compressor Facility. Measurements were acquired in a 20-in.-diameter transonic compressor rotor operating at 17,188 rpm. A custom-designed light-sheet-generating probe was used to insert the high-energy, pulsed light-sheet illumination required for recording the unblurred images of particles entrained in the fluid. Measurements of the shock wave formed within the rotor blade passage and of unsteady structures within the blade wakes were acquired. These measurements provide insight into unsteady spatial structures in the flow field which cannot be measured with the more conventional laser anemometry technique. The PIV technique provides both instantaneous and average velocity data in a transonic compressor in an order of magnitude less time than required for other conventional optical diagnostic techniques.



Top: PIV system installed in W-8 transonic compressor facility. Bottom: Average of 110 instantaneous PIV velocity vector maps.

Bibliography

Wernet, M.P.: Demonstration of PIV in a Transonic Compressor. NASA TM-113164, 1997.

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