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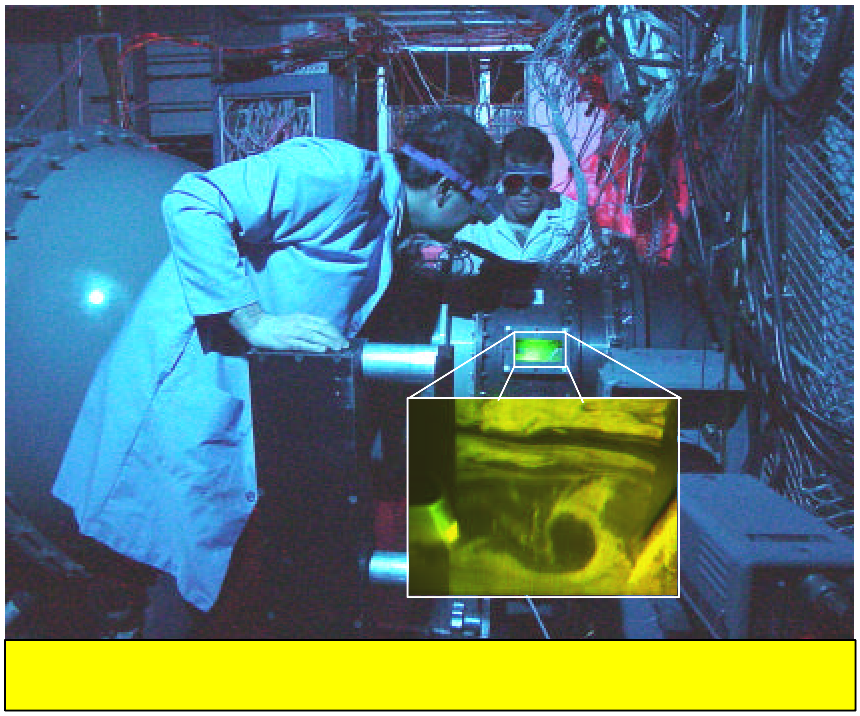
Science and Technology for Tomorrow's Aerospace Force

Success Story

PROPULSION INVESTIGATOR'S ACHIEVE FIRST LOOK INTO COMPLEX FLOW FIELDS



A collaboration of the Propulsion Directorate and Innovative Scientific Solutions Inc. (ISSI) scientists produced the world's first digital particle image velocimetry (DPIV) investigation of flow fields between closely-spaced blade rows in a transonic compressor. Now for the first time, investigators can examine the complex fluid interactions that occur between the blade rows in a turbine engine's compressor. New insights into turbomachinery design methods are now possible as a result of this pioneering effort. Used as a benchmark for modeling and simulation code validation, the results can significantly reduce maintenance costs through understanding and preventing high-cycle fatigue problems.

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Accomplishment

Directorate and ISSI researchers investigated the flow field kinematics between transonic compressor blade rows by using advanced laser DPIV specifically adapted to their compressor aero research lab (CARL). This work resulted in the world's first real-time, instantaneous, visual insight into the complex interactions that occur in such designs. Directorate researchers modified the CARL stage matching investigation rig, installing laser optics and a viewing window for visual observation and digital photography. Images of the seeded flow can be processed to yield such kinematic properties as velocity and vorticity. This flow visualization will provide initial understanding of the actual flow between blade rows and inside the transonic compressor.

Background

Future military engines will be designed with compressors which have closely spaced and highly loaded blade rows. Research at CARL demonstrated the potential for losses in efficiency when blade row spacing is reduced. Current design tools are based on steady Navier-Stokes analysis with unsteady interactions being modeled as deterministic stresses. Previous experimental methods, such as laser transit anemometry LTA and laser doppler velocimetry for validating unsteady design tools, were limited, extremely time consuming, and costly. An efficient experimental technique for capturing the instantaneous nature of the unsteady flow structures is critical to properly accounted for unsteady influence in design. If these influences are not well understood, a greater potential for performance reductions, blade fatigue and increases in operational costs.

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Additional information

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