August 1971

Brief 71-10252

NASA TECH BRIEF

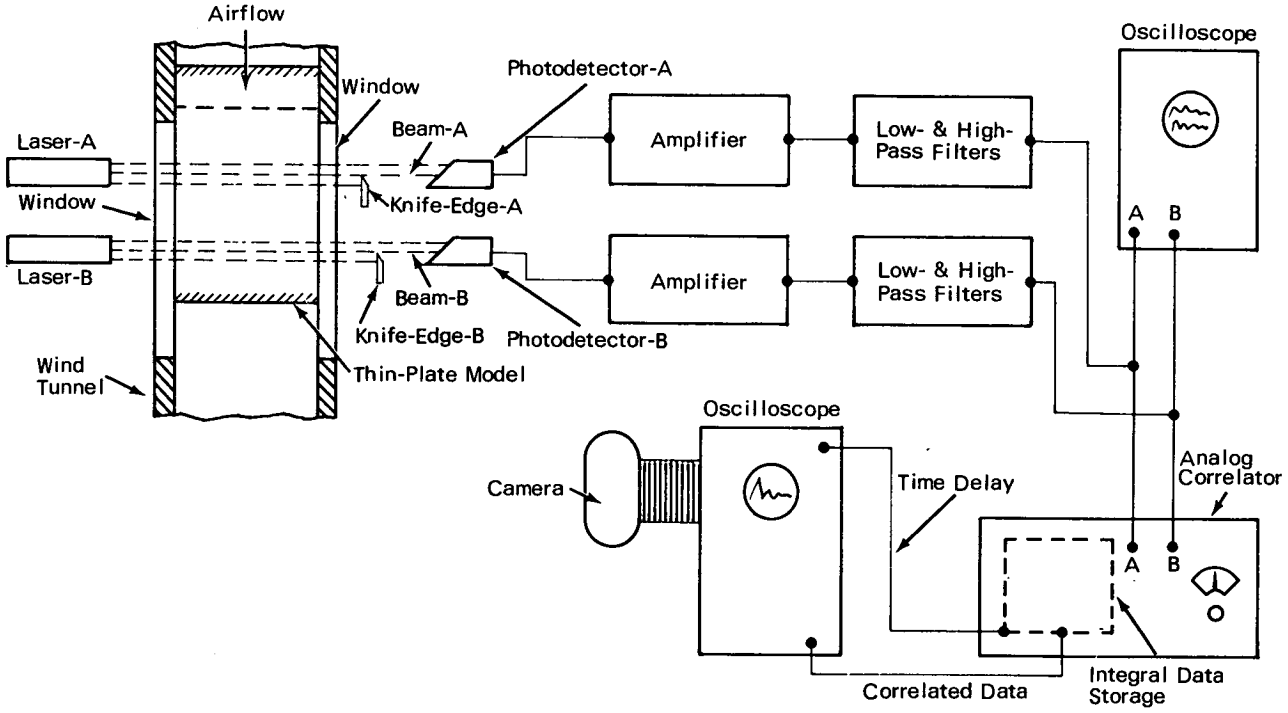
Marshall Space Flight Center

Optical Probing of Supersonic Flows with Statistical Correlation

A remote sensing tool reliably measures the statistical properties of supersonic turbulence. The characteristics of supersonic flow are determined by an optical system with deflections (Schlieren effects) in two laser beams being converted into readable electrical signals. The tool neither affects nor is adversely affected by the flow field.

Two laser beams are directed through the supersonic boundary layer in the test section of a wind tunnel. If the layer is two dimensional, the beams may be placed parallel to each other; otherwise they are positioned so that the volume of flow under examination is restricted to that volume common to both beams.

The turbulence crossing both beams may be more easily correlated statistically by using a knife-edge before a photodetector. Because the edge is rotatable, both translational and rotational motions of turbulent-flow structures may be determined. The signals from the photodetector are correlated by computer, and the correlated data signal is fed into an oscilloscope or comparable display apparatus.



Apparatus with Two-Dimensional Wind Flow; Schematic

Thus, the device (1) determines the characteristics of supersonic flow with an optical system, and (2)

(continued overleaf)

provides a method and apparatus for separating the translational and rotational motions of turbulent structures in supersonic flow.

The figure shows a schematic of a wind tunnel test section having two opposed windows and housing a thin-plate model to cause substantially two-dimensional airflow turbulence. A collimated beam from Laser-A crosses the airflow upstream, and in the supersonic turbulent boundary layer; beam-A is then received by photodetector-A (a photometer). Rotatable knife-edge-A is positioned before photodetector-A in such a way that approximately 50% of the light is blocked from the photodetector. The collimated beam from Laser-B crosses the airflow downstream of beam-A; beam-B is then received by photodetector-B. Rotatable knife-edge-B is positioned before its photodetector such that approximately 50% of the light is kept from the detector.

Signals from the two photodetectors, reflecting disturbances of the two laser beams by disturbances in the airflow, pass through separate amplifiers and filters to an analog correlator. The correlated data are then fed to an oscilloscope, where a camera photographs the display. The amplified and filtered raw data from the detectors are viewed in a second oscilloscope.

Many modifications and variations of the system are possible, including replacing the two lasers with a single laser, beam splitter, and mirrors.

Note:

The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0.95)

Reference:
NASA-TM-X-53870 (N70-12209), A Direct Measurement of the Most Probable Preferred Angular Velocity of Turbulent Structures by Optical Correlation of Laser Schlieren Signals

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

Patent Counsel
Mail Code A&TS-PAT
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Source: B. H. Funk
Marshall Space Flight Center
(MFS-20642)