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FUEL SPRAY DIAGNOSTICS

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To understand the combustion process of liquid reactants, it is necessary to obtain information about the distribution and atomization of the injected liquid phase. Turbulence and relative velocities between the fuel's gas phase and liquid droplets affect the evaporation, burning rate and pollutant formation. This will affect other combustor performance parameters such as combustion efficiency, pollutant emissions and combustion stability. The measurement of size and velocity distribution of the liquid injected into the combustor is of vital necessity. The experimental data will be used by numerical modelers in deriving mathematical relationships that will describe the combustion process.

Several laser measurement methods are being studied to provide the capability to make droplet size and velocity measurements under a variety of spray conditions. The Droplet Sizing Interferometer (DSI) has promised to be a successful technique because of its capability for rapid data acquisition, compilation and analysis. Its main advantage is the ability to obtain size and velocity measurements in air-fuel mixing studies and hot flows.

The existing DSI at NASA Lewis is a two-color, two-component system. Two independent orthogonal measurements of size and velocity components can be made simultaneously. It also uses an off axis large angle light scatter detection. The fundamental features of the system are optics, signal processing and data management system. The major component include a transmitter unit, two receiver units, two signal processors, two data management systems, two Bragg cell systems, two printer/plotters, a laser, power supply and color monitor.

The laser diagnostic investigation will consist of various experiment configurations for fuel nozzle characterization tests. Water will be used as a fuel substitute. General probe volume positions will be obtained for mapping the fuel nozzle flow distribution and variations with test conditions. A fuel nozzle/swirler combination will simulate fuel/air mixing characteristics; small particles will be used for seeding the flow field.

Two contracts have been awarded for further development and improvements to the system. These contract efforts promise to extend the size range capability, reduce beam alignment difficulties and reduce the system sensitivity to laser beam quality and differences in the relative intensity of the beams.

REFERENCES

1. Bachalo, W. D.; Hess, O. F.; and Hartwell, C. A.: An Instrument for Spray Droplet Size and Velocity Measurements. J. Eng. Power, Vol. 102, No. 4, Oct. 1980, pp. 798-806.

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2. Bachalo, W. D.: Method for Measuring the Size and Velocity of Spheres by Dual-Beam Light-Scatter Interferometry. Applied Optics, Vol. 19, p. 363, Feb. 1980.

3. Mularz, E. J.; Bosque, M. A.; and Humenik, F. M.: Detailed Full Spray Analysis Techniques, NASA TM-83476, 1983.

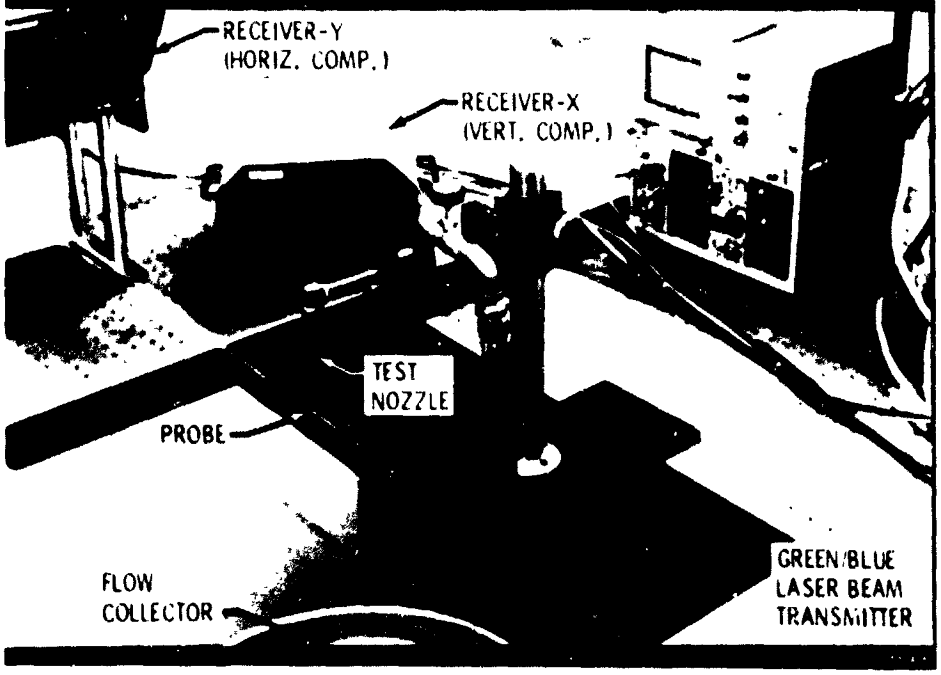
FUEL SPRAY DIAGNOSTICS PROGRAM

PURPOSE
- CONDUCT FUNDAMENTAL COMBUSTION PROCESS RESEARCH USING DIAGNOSTIC MEASUREMENTS FROM A UNIQUE LASER INTERFEROMETER APPARATUS.

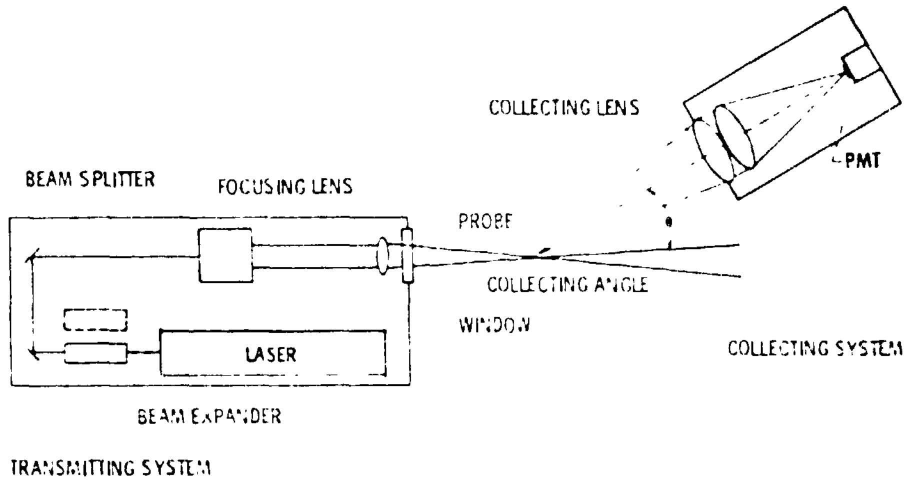
METHOD
- NON-INTRUSIVE MEASUREMENT PROBE FORMED BY COHERENT LASER BEAMS THAT PRODUCE INTERFERENCE FRINGE BANDS.
- DROPLETS/PARTICLES GENERATE LIGHT SCATTER PATTERNS WHICH ARE DETECTED WITH PMT.

YIELD
- FAST REAL TIME DATA ANALYSIS OF FLOW CHARACTERISTICS.

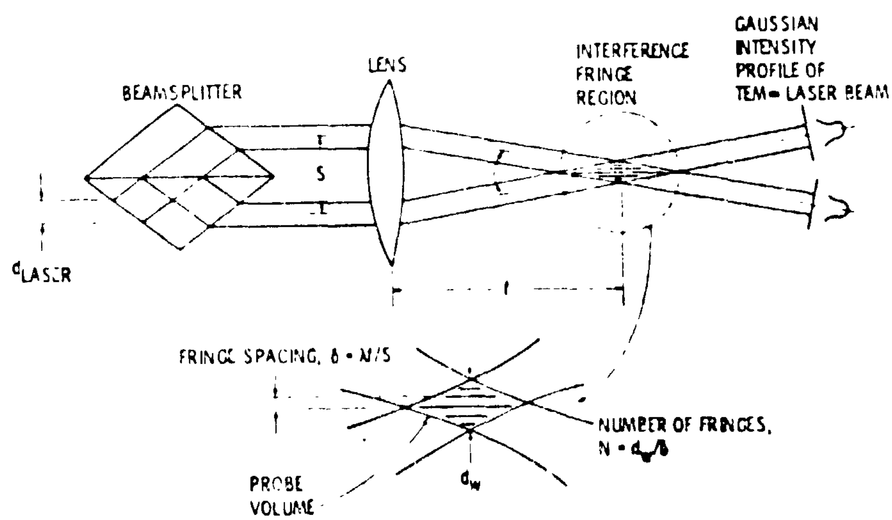
FUEL NOZZLE SPRAY CHARACTERIZATION
TWO-COMPONENT DROPLET SIZING INTERFEROMETER SYSTEM



DROPLET SIZING INTERFEROMETER SYSTEM LINE DRAWING (ONE-COMPONENT)



FORMATION OF FRINGES IN PROBE VOLUME OF DSI



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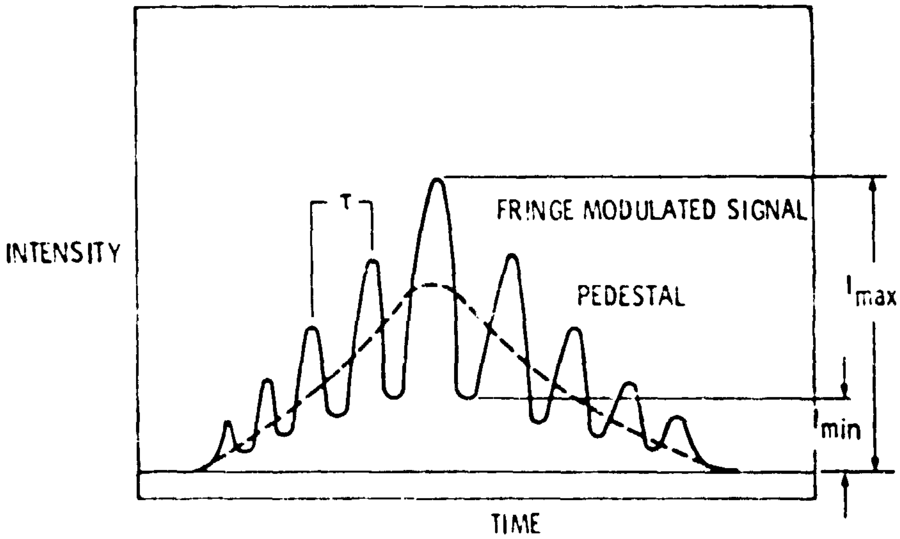
DOPPLER BURST SIGNAL



NOZZLE CHARACTERIZATION TEST

Nozzle	Delavan-Hollow cone ([illegible])
Position	3.8 inches from nozzle
Airflow rate	[illegible] scfm max.
Water flow rate	[illegible] scfm max.
Pressure	[illegible] psig.
Temperature	[illegible] F

(This nozzle has been previously characterized with a Malvern System)

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NASA LeRC FUEL SPRAY DIAGNOSTICS PROGRAM

EXPERIMENT DESCRIPTION
•SPRAY CHARACTERIZATION - H_2O - VARIOUS NOZZLE TYPES - PRESSURE DIFFERENTIAL EFFECTS SIZE AND VELOCITY DISTRIBUTION - SEVERAL SAMPLING PLANES
•TURBULENCE STUDIES - SEEDED - VARIOUS AIR SWIRLER CONFIGURATIONS - VANE ANGLE EFFECTS - AIRFLOW SPLITS
•FUEL-AIR REACTION STUDIES - VARIOUS EQUIVALENCE RATIOS - FUEL PROPERTY EFFECTS - MEASURE TURBULENCE INTENSITY

RESOURCES

- FUEL SPRAY DIAGNOSTICS FACILITY
  (SW-5, ERB, NASA LEWIS)
- DEVELOPMENT AND IMPLEMENTATION OF ADVANCED DIAGNOSTIC TECHNIQUES
  (SPECTRON DEVELOPMENT LABORATORIES, INC., CALIFORNIA)
- PHASE DETECTION TECHNIQUE STUDY
  (AEROMETRICS, INC., CALIFORNIA)
- MEASUREMENT OF SPRAY COMBUSTION PROCESSES
  (UTSI GRANT, TENNESSEE)
- COMBUSTION CHARACTERISTICS IN THE TRANSITION REGION OF LIQUID FLUID SPRAYS
  (DREXEL UNIVERSITY GRANT, PHILADELPHIA)