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FLUID MECHANICAL OPTICS AND FLUID MECHANICS RESEARCH
(U) WASHINGTON UNIV SEATTLE M H CHRISTIANSEN ET AL.
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SECURITY CLASSIFICATION OF THIS PAGE

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FINAL REPORT

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FLUID MECHANICAL OPTICS AND FLUID MECHANICS RESEARCH
AFOSR 84-0167

July 1, 1984 - June 30, 1985

Walter H. Christiansen

EQUIPMENT PURCHASES:

The following is a partial list of equipment purchased using DOD-University Research Instrumentation funds:

Work Stations:

- 3-VAXI work stations including 6 VT 240 terminals and 3 printers and 3 modems and other communication gear. - Digital Equipment Corp. \$ 43,225

VAX Computer System

- 1 VAX 11/750 computer system with communication capability including 1 Disc RUA81 and Tape TU80 with VT-220 terminals, printer and operating software including a Fortran compiler, 40,900
- 1 high speed printer P-300 Printronex; 6,600

Specialty Equipment for Work Stations

- 1 12-bit high speed A/D connector for WS data translation; 3,400
- 1 Q Bus frame buffer and processor imaging technology; 7,225
- 1 CCD TV camera Pulnix; 1,500
- 1 VCR Panasonic, VHS type; 1,750
- 1 image acquisition system for a work station; Model #7405 Microtex 30,400

TOTAL \$135,000

In addition to DOD funds, financial support was obtained from the University and the Department of Aeronautics and Astronautics. The cost of the VAX 11/750 is considerably higher than that indicated by the DOD support in this report. The University entered into an agreement with Digital Equipment Corporation late in 1984, permitting us to substitute newer and more powerful 32-bit micro-VAX work stations for the 16-bit PDP-11's called for in the original equipment list at no extra cost. We were fortunate to acquire this modern equipment for our laboratory.

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UTILIZATION SUMMARY

The following research projects were utilizing the equipment during the contract period.

1. Project Title: "Optical Properties of Compressible Shear Layers Relevant to High Power Lasers"
Principal Investigator: Walter H. Christiansen
Sponsor: AFOSR

Shear layers and wakes are a major source of optical degradation of high power laser beams. We are studying experimentally the structure of these flows with special attention given to their optical properties. Gases with different refractive indices are being investigated because of their importance in laser flows. The effects of density ratio and Mach number on optical performance are being measured. Modeling the properties of these flows will be carried out concurrently, in order to be able to predict the optical degradation caused by these layers.

2. Project Title: "Mixing of Swirling Flows, Behavior of Wet Flows and Flow in Ramjet Inlets"
Principal Investigator: Gordon C. Oates
Sponsor: AFOSR

A program is currently being conducted under funding from AFOSR to investigate the behavior of very wet flows interacting with shock waves to study the behavior of multi-hole probes in the vicinity of solid boundaries and in the presence of sheared flows, and to investigate the behavior of shock trains in ramjet inlets. These studies are being continued and we are preparing to publish the results of two studies previously supported by the grant.

3. Project Title: "Boundary Condition Procedures for Implicit Methods"
Principal Investigator: Robert W. MacCormack
Sponsor: AFOSR

The success or failure of applying an implicit method to solve a fluid flow problem of practical interest is largely determined by the boundary condition procedure. Implicit methods designed to take large time step sizes at interior points of the flow fluid often encounter difficulties near boundaries unless the step size is severely limited. To reach the full potential of implicit methods requires the development of new boundary condition procedures capable of correctly processing and transmitting information during large time step intervals. The proposed study presents a promising new boundary condition procedure. The study will implement and evaluate this procedure for use in solving compressible viscous flow problems and compare its results with those of other existing procedures.

4. Project Title: "Gas Optics Applicable to Free Electron Laser Technology"
Principal Investigator: Walter H. Christiansen
Sponsor: Office of Naval Research/DARPA

The free electron laser has the potential of being a highly efficient short wavelength laser. The designs of these lasers are hampered by excessively long optical cavities required by practical considerations of the mirror reflectors. A solution to this problem may be the use of defocussing gas optics in conjunction with the traditional mirror optics. A program of experimental and theoretical research is to be carried out to study the various aspects of gas optics for use with the free electron laser.

The following project has just started to use the equipment:

5. Project Title: "An Exploratory Study of Ram Accelerator Principles"
Principal Investigator: A. Hertzberg
Sponsor: AFATL

A combustion-driven ram accelerator concept is being studied. An experimental program is proposed in which the fundamental gasdynamics and physics of this device will be studied on a small scale. In addition, a comprehensive theoretical investigation will be carried out to determine the performance limits of various ram accelerator geometries from moderate to ultrahigh velocities (i.e., 2-25 km/sec). This research is considered a precursor to a larger program involving full-scale prototype proof-of-concept experiments.

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