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NRL Memorandum Report 5352

# Software for a Computer Controlled Laser Doppler Velocimeter

C. R. KAPLAN, S. R. LUSTIG AND F. W. WILLIAMS

*Combustion and Fuels Branch  
Chemistry Division*

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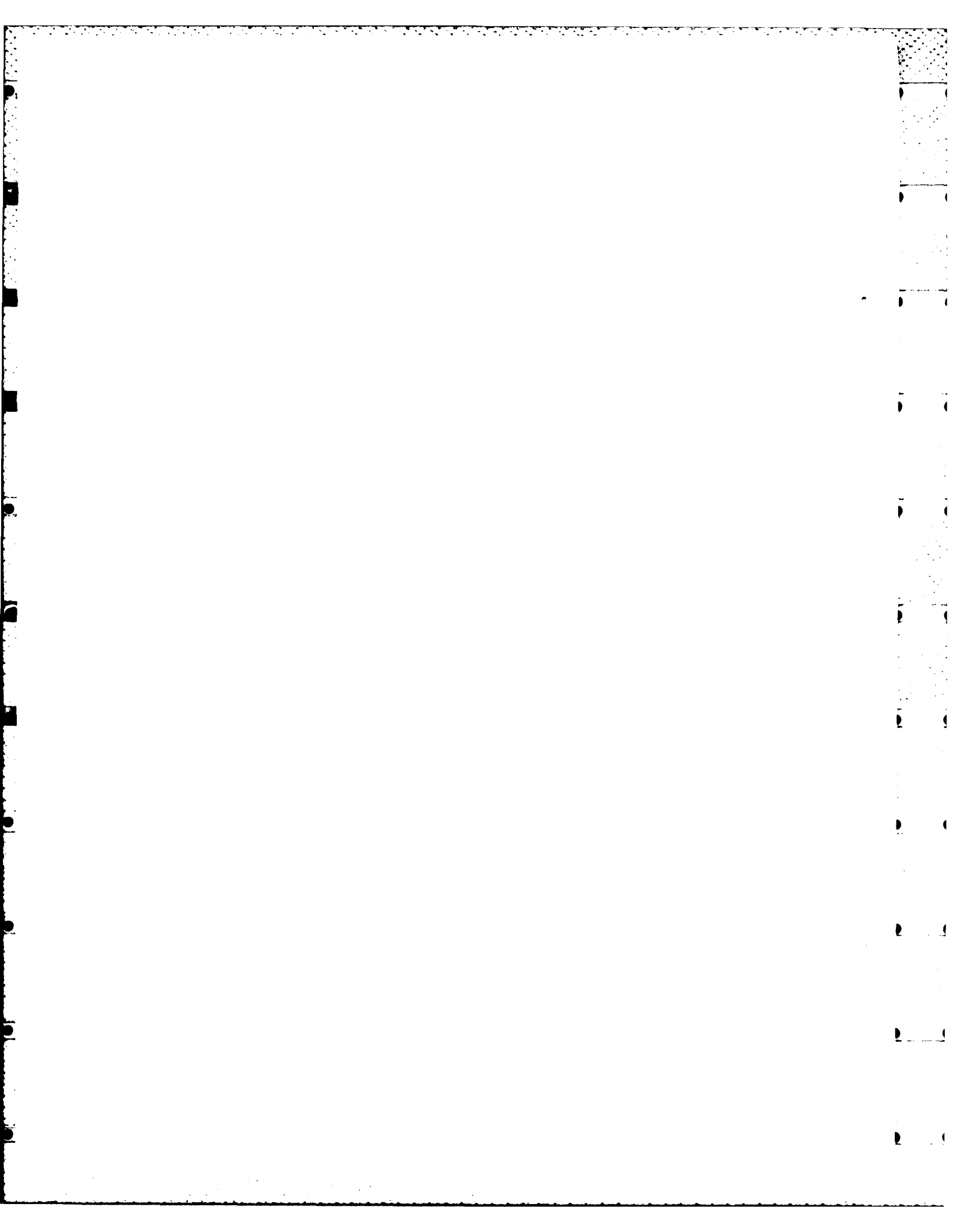
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<p>Software, consisting of a main FORTRAN program and an assembly language driver, has been developed for the computer control of a laser doppler velocimeter (LDV). This is part of a continuing effort in the use of the LDV to measure turbulence in combustion processes. A brief discussion of the LDV hardware is included. An illustrative example follows to demonstrate software capabilities.</p>				
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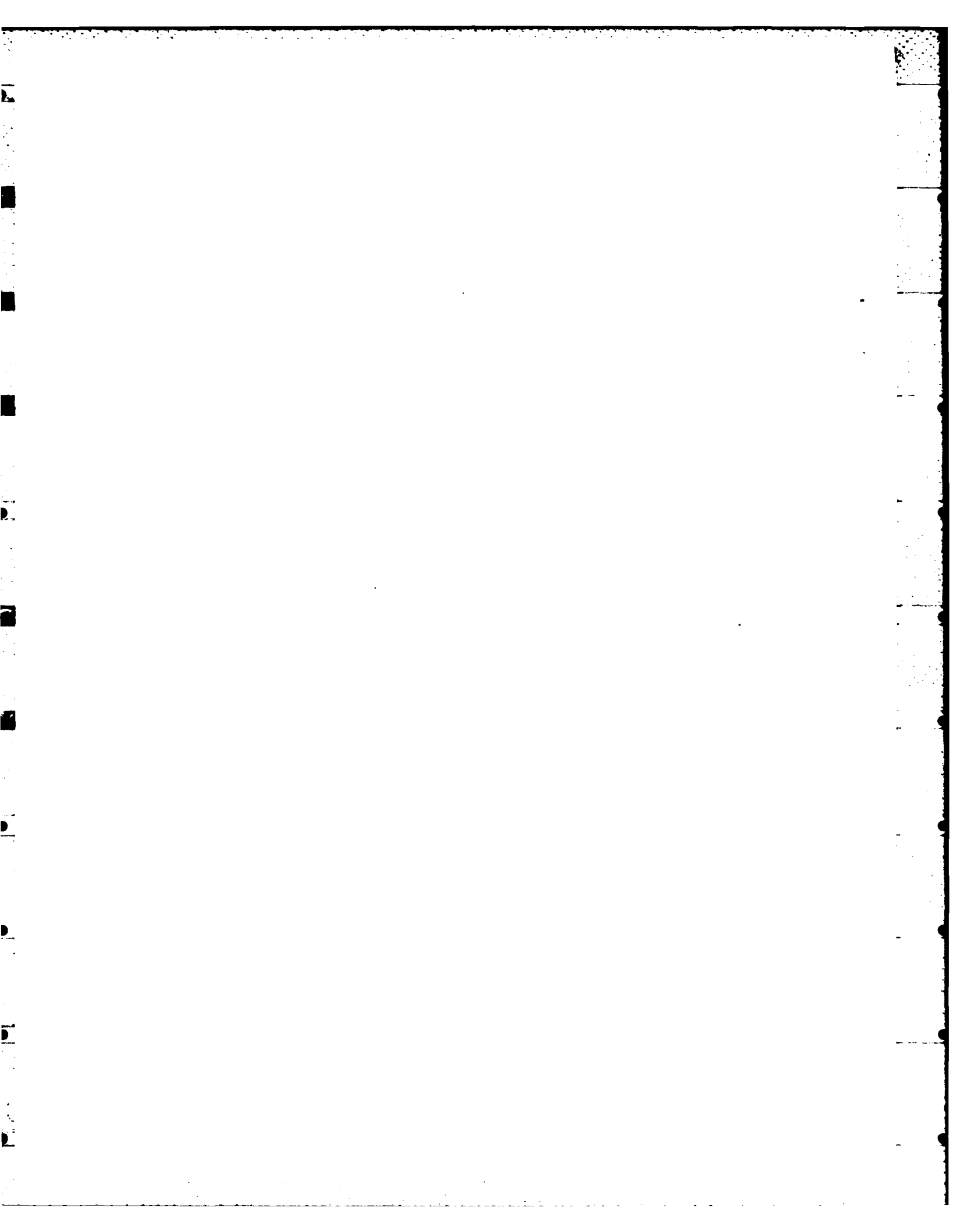
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## SOFTWARE FOR A COMPUTER CONTROLLED LASER DOPPLER VELOCIMETER

### I. INTRODUCTION

The hazard associated with fire in confined spaces is critical to the Navy due to the vulnerability of a ship to the disastrous effects of an uncontrollable fire. An understanding of the physical mixing processes in diffusion flames, which are characteristic of most unwanted fires, is necessary. By knowing the mixing patterns, a better understanding of fire growth in confined areas can be developed. This ultimately will lead to ways of controlling materials, geometry, design and structure to fire harden our ships more. The need for better mixing information has prompted research efforts toward the development of a technique to measure turbulence in combustion processes using laser doppler velocimetry (LDV).

The LDV is a state-of-the-art diagnostic tool to measure the velocity of particles moving in a flow field. The ability to characterize highly turbulent flow fluctuations at near zero mean velocity and to make measurements without obstructing the flow makes turbulence measurement via LDV preferable to that of other developed methods, such as the hot wire anemometer. The inability of the hot wire anemometer to measure turbulence in smoke-laden environments makes the LDV approach particularly attractive (1,2).

The principle behind laser doppler velocimetry lies in the phenomenon that particles suspended in a flow field will scatter laser light that is directed upon them. The frequency of the scattered light depends on the particle velocity and the angle through which the light has been scattered. The frequency of the scattered light is different from the frequency of the incident laser light. This frequency difference is the doppler frequency, which can be detected by electronic processing.

This is a continuing research effort, the result of which, to date, has been the development of computer software to control the LDV system. An example run follows, for illustrative purposes in demonstration of the software capabilities.

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## II. EQUIPMENT

The LDV System (Disa Electronics) is comprised of a two-color laser and associated optics, two counter processors, electronic frequency shifters, and a buffer interface. Figure 1 illustrates the overall schematic of the LDV system. The pieces of the equipment describing the LDV System are described below.

### II. A. LASER

The blue/green colored beam from a four watt, argon ion laser is passed through a series of color-neutral and color-separating beam splitters to create three beams, blue/green, green and blue, as shown in Figure 2. The three beams are focused by the transmitting optics to an intersection point, approximately 16 feet from the laser where the fluid whose flow patterns are being measured is located. The purpose of choosing such an unusually large focal length (most LDV systems employ a three to four foot focal length) is to have the capability, when necessary, to make measurements during large scale fire tests where it is desirable to keep the hardware at a sufficiently large distance from the fire source.

The intersection of the green and blue/green beams results in the formation of interference fringes. A particle from the flow field which passes through the interference fringes scatters light, the intensity of which rises and falls as the particle moves from bright fringe to dark fringe. This scattered light is collected on a photomultiplier tube in the backscatter mode and converted to a frequency-modulated current burst. Further processing occurs in the counter processors (as discussed below) to give the vertical component of velocity of the particle in the flow field. The intersection of the blue and blue/green beams similarly creates interference fringes from which a particle passing through scatters light. This scattered light is collected on a second photomultiplier tube, converted to a doppler signal, and further processed in the second counter processor to give the horizontal velocity component of the same particle in the flow field.

### II. B. COUNTER PROCESSOR

The frequency-modulated current burst from each of the photomultipliers is amplified and band-pass filtered in separate counter processors. Each burst represents the passage of a single particle and contains information on the number of fringes passed by the particle. The frequency of the doppler burst signal is detected by internal logic circuitry. The distance between the fringes is known from the geometry of the optical beams and the wavelength of the laser

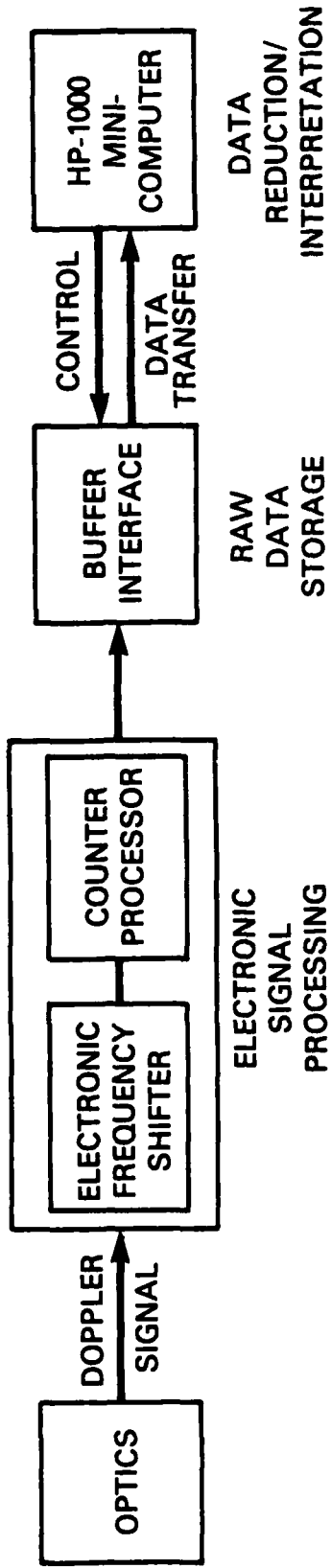


Figure 1. Schematic of LDV System

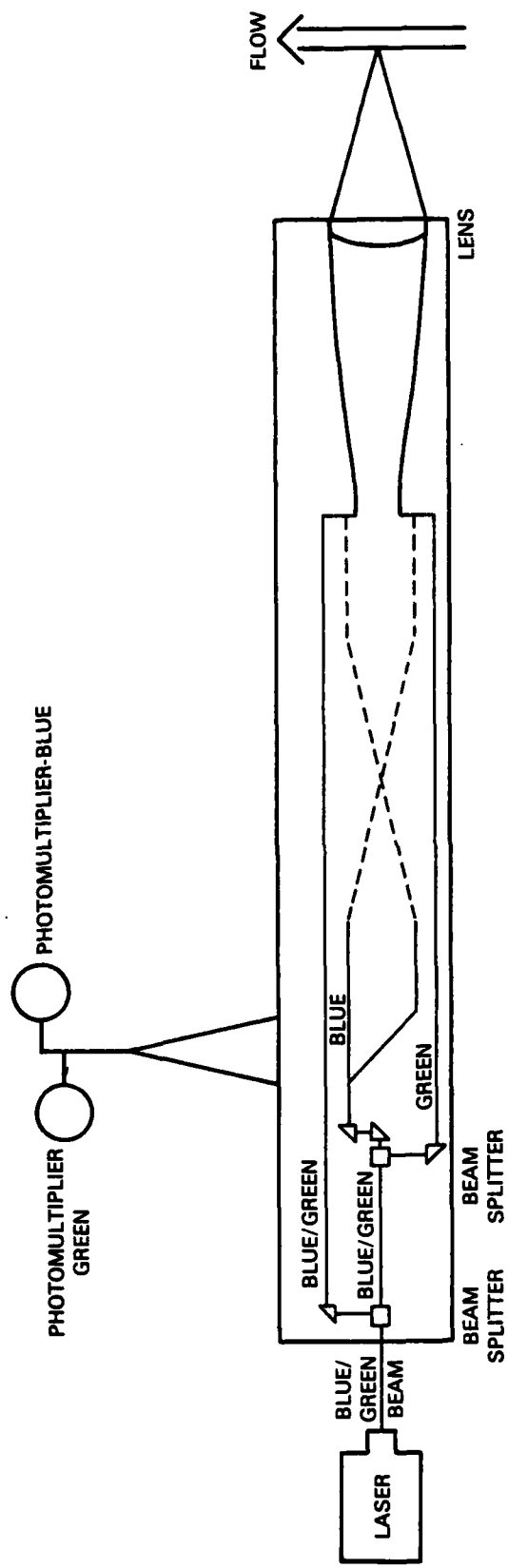


Figure 2. Optical arrangement in backscatter mode resulting in separate blue, green and combination blue/green laser beams, which intersect to form interference fringes. Particles in flow-field scatter light, the intensity of which rises and falls as the particle moves from bright fringe to dark fringe.

line. Instantaneous particle velocity may then be calculated by multiplying the fringe spacing by the measured doppler signal frequency.

The counter processors have the capability to send four types of data to the buffer interface. Doppler frequency data and sample interval time (time interval between each successive validated signal) data are contained on the pins of one of the rear panel multi-connectors of the counter processor. The other gives information on the number of fringes and burst time, i.e., time between each doppler burst.

## II. C. BUFFER INTERFACE

The Buffer Interface acts as a data and control interface in the transfer of digital data between the counter processors and the Hewlett-Packard-1000 mini-computer. It functions as a buffer memory for the randomly arriving data from the counter processors before it is transferred to the HP-1000. It also receives the control words from the computer, as written in the software, so that the LDV will operate with the appropriate data and control channels opened.

Synchronization within a selected time interval between the data from the two counter processors is achieved with the coincidence filter board inside the Buffer Interface. The selection of input and output channels and the setting of coincidence time intervals are all software-controlled.

The Buffer Interface has been designed to interface with the DEC PDP-11 mini-computer family. An additional circuit board was added to the Buffer Interface which converts the control and data format to that of the HP Microcircuit Board 12566B for Hewlett Packard mini-computer in the 2100 series.

Data are transferred from the additional interface board, with a 16 bit, parallel full duplex format, to the 12566 Board of the HP 21MX series mini-computer. The 12566 Board has 16 bit input and output registers. A system of electronic "handshakes" controls the signal and data lines, as described in the software section of this report.

## III. SOFTWARE

The transfer of information to and from the LDV is software controlled. Control of the LDV by the HP-1000 computer is achieved by a software driver. The driver is called by the main FORTRAN program, program LDV, both of which were written at the Naval Research Laboratory (NRL) and are discussed in the following sections.

### III. A. DRIVER

A relocatable HP-assembly language driver was written to enable the computer to communicate with the LDV Buffer Interface. The driver, as shown in Appendix A, is FORTRAN callable, and contains all of the necessary "set control," "set flag," etc. instructions to control and read data from the LDV.

A non-interrupt data transfer method was chosen due to the higher degree of ease with which this type of driver could be written compared to that of an interrupt-type driver. The non-interrupt method involves a "wait-for-flag" routine when inputting LDV data into the data-register. The computer signals the interface card to start the LDV device. The driver loops until the LDV is ready to input data into the data-register. Readiness to input data is expressed by setting a flag flip-flop. After the flag is set, the program continues. At times, the doppler signal is of insufficient strength to cause the flag to set. To prevent the driver from looping indefinitely, a routine to wait 1000 times for the flag was incorporated. If the flag does not set after 1000 attempts, the program is terminated. The wait-for-flag routine is not required when outputting control words from the computer to the LDV.

The memory protect logic feature, which is incorporated in the HP-1000 Real Time Executive operating system, limits control of all Input/Output operations to interrupt control only. Thus, the memory protect fence is disabled by assembly language software, so that the non-interrupt driver has control of the LDV.

The driver consists of two main segments, the initiation section and the continuation section. The initiation section performs two basic functions: (a) to clear the buffer memory before a new record of data is to be entered, and (b) to send the control words to the LDV.

The collection of data is accomplished in the continuation section. Counting variables are incremented each time a data word is collected so that data rate can be acknowledged. The memory protect fence is re-enabled after a buffer of data is collected. This gives the interrupt system control of the input/output peripheral devices before returning to main FORTRAN program. Three control words are sent to the LDV which open up appropriate channels for data collection. The control words, which are collected in the initiation section of the driver and are sent out in the main program, perform three functions.

The first word turns on the coincidence filter board and opens up channels 1 and 2. The second control word sets the time interval between successive samples to 125 microseconds. This will ensure that the data from the two counter processors will be synchronized within this time interval. The third control word is the static control word and must remain set during operation. Channels 1 and 2 (connected with the counter processors) and channel 4 (connected with the Coincidence Filter Board) are opened for input. Doppler frequency data and sample interval data may be simultaneously collected from one of the multi-connectors on the counter processor; fringe number and burst time data are simultaneously collected from the other.

Because the 12566 Board does not give a data transmitted signal after a data word has been read into the computer, this signal is created artificially by transmitting a device command signal with the address of octal 60000. In both the initiation and continuation sections, the number 60000 (octal) is loaded into the B register. The instructions OTB LDV (output the contents of the B register to the LDV) and STC LDV (set the control flip flop on the LDV interface card in the computer I/O cage) result in the artificial creation of a data transmitted signal.

### III. B. PROGRAM LDV

The main FORTRAN program, as shown in Appendix B, is comprised of three main sections which contain calls to the assembly language driver and calls to several subroutines. The first segment is used to test the LDV by taking samples and writing this out to any terminal. The user may specify any control words that are desired. This is a good way to test to see if the different channels which are opened are actually sending data.

The second segment is used to collect data for a user-specified amount of time and writes the raw data to a created disc file. The maximum number of 512 data transfer words can be collected in a record, as this is the size of buffer memory in the Buffer Interface. The number of data words collected, represented by the variable ICNT, is one of the variables passed to the driver from the main program, which enables the calculation of data rate.

Segment number three is used to sort and assemble the raw data collected on the disc file created by segment number two. A second data file is created which contains the sorted data. This segment reads in a record of data of up to 512 words from the raw data file. Subroutine ASMBL, which is then called, evaluates each data word based on the type of information that corresponds to each of the 16 bits comprising the data words.

This information is passed to subroutine SORT which identifies the data as either doppler frequency data, sample interval data, number of fringes data, or burst time data. Doppler frequency data is converted to velocity, by the following relationship:

$$\text{Velocity} = \text{Doppler Frequency} \times \text{Fringe Spacing}$$

where

$$\text{Fringe Spacing} = \frac{\lambda}{2 \sin \theta/2}$$

$\lambda$  = laser wavelength

$\theta$  = angle of intersection of laser beams

Summations of the velocity data are performed in Subroutine STAT for the purpose of calculating average velocity at a subsequent point in the program. Subroutine GATHR groups the velocity and sample interval time data by burst and writes the assembled data to the output file. At this point, program statement number 310, the program loops back up to program statement number 309 to read the next record of data of up to 512 words from the raw data file.

After the final record of data has been written to the output file, Subroutine STAT calculates average velocity for each of the counters, i.e., horizontal and vertical component, and the magnitude and direction of the resultant velocity vector.

#### IV. EXAMPLE RUN

The following example is intended as an illustration of the utility of the software in transferring information to and from the LDV.

The vertical and horizontal components of velocity were measured in a test run for one point in a 6 cm methanol pan fire. The laser beam intersected at a vertical position 1 cm above the lip of the pan and in the center of the pan in the horizontal direction. The liquid level of methanol was maintained constant (3). Data were collected for approximately 30 minutes.

The lack of formation of soot particles in the methanol flame, due to methanol's clean burning characteristics, creates some difficulty with LDV measurement. The principle behind the LDV technique rests in the fact that particles in the flow field will scatter laser light that is directed upon them. A very sparse particle concentration, such as with

methanol, results in a very low data rate and small amplitude doppler bursts. A doppler signal of amplitude less than 200 millivolts will not be validated in the counter processors, resulting in a near zero data rate. The unusually long focal length of 16 feet also contributes to a smaller doppler signal in comparison to a short focal length, as the light scattered from the particles in the flow field travels a longer distance before being collected in the photomultiplier tube. The longer distance travelled by the scattered light results in reduced signal strength.

In this run, the doppler signal was boosted by adding small amounts of n-heptane to the fuel pan. This resulted in a more soot-laden flame of orange color. The flame was placed inside a wooden box with several small cut-out holes for ventilation. The box served to stabilize the flame from the air currents created by the nearby hood and air ducts, as well as to elevate the smoke particle concentration near the flame to boost the doppler signal strength.

Appendix C contains a listing of the data which has been grouped by doppler burst. Column #2 lists velocity in the vertical direction (meters per sec), column #3 lists velocity in the horizontal direction, and column #4 gives the sample interval time for that doppler burst from which the data is generated. For the vertical component, a positive number indicates the upward direction, while negative indicates downward. A positive number for the horizontal component indicates a direction to the right. After processing all of the data, the unweighted mean velocity, as calculated from all the data points, is shown along with the angle of the velocity vector, in reference to the vertical position.

## V. CONCLUSIONS

In a continuing effort to understand the physical mixing processes in diffusion flames, NRL is currently involved in the development of a technique to measure the velocity profile in combustion processes using the laser doppler velocimeter. To date, the software has been developed for a computer-controlled LDV. Further work is required in the areas of seeding the flow field to boost the signal to noise ratio of the doppler signal to make this a viable research tool.

## VI. REFERENCES

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2. Stevenson, W. H., Thompson, H. D. and Gould, R. D., "Laser Velocimeter Measurements and Analysis in Turbulent Flows with Combustion, Part II," School of Mechanical Engineering, Purdue University, Report No. AFWAL-TR-82-2076, July 1983.
3. Alexander, J. I., St. Aubin, H. J., Stone, J. P., Street, T. T. and Williams, F. W., "Large-Scale Pressurizable Fire Test Facility - FIRE I," NRL Formal Report 8643, 30 December 1982.

APPENDIX A - SOFTWARE DRIVER

DRVR 7=00003 IS ON CR00041 USING 00015 BLKS R=0000

```

0001 ASMB,R,L
0002     NAM DRVR,7   USER WRITTEN DRIVER(SELECT CODE=10B)
0003     ENT DRVR
0004     EXT .ENTR,$LIBR,$LIBX
0005     *
0006     * FIND ADDRESSES OF PASSED VARIABLES
0007     ICODE NOP
0008     IDATA NOP
0009     IDL  NOP
0010     ISCW NOP
0011     ISL  NOP
0012     ICNT NOP
0013     IFLAG NOP
0014     DRVR NOP
0015     JSB .ENTR
0016     DEF ICODE
0017     *
0018     * DEFINE SELECT CODE OF 12566 BOARD
0019     LDV  EQU 10B
0020     *
0021     * DETERMINE TASK:
0022     LDA ICODE,I       ICODE=1 DO INITIATION SECTION ONLY
0023     CPA TWO           ICODE=2 DO CONTINUATION SECTION ONLY
0024     JMP CONT         ICODE=3 DO BOTH SECTIONS
0025     *****
0026     * INITIATION SECTION: *
0027     *****
0028     LDB DC           KEEP 60000B IN B
0029     LDA K1           SAVE MEMORY SIZE TO CLEAR
0030     CMA,INA
0031     STA CNT1
0032     LDA ISL,I       USE ISCW LENGTH AS A COUNTER
0033     CMA,INA
0034     STA CNT2
0035     LDA ISCW        SAVE ADDRESS OF CONTROL BUFFER
0036     STA PTR1
0037     *
0038     * DISABLE THE MEMORY PROTECT FENCE
0039     JSB $LIBR      GO PRIVILEGED
0040     NOP
0041     *
0042     * CLEAR THE USED BUFFER MEMORY
0043     CLEAR NOP
0044     OTB LDV
0045     STC LDV,C
0046     CLC LDV
0047     ISZ CNT1
0048     JMP CLEAR
0049     *
0050     * SEND OUT CONTROL WORDS TO INTERFACE
0051     SEND LDA PTR1,I
0052     OTA LDV
0053     STC LDV,C
0054     CLC LDV
0055     ISZ PTR1       INCREMENT BUFFER ADDRESSES
0056     ISZ CNT2       AND COUNTER
0057     JMP SEND
0058     *

```

```

0059 * RETURN IF ICODE=1
0060     LDA ICODE,I
0061     CPA ONE
0062     JMP BYE
0063 *****
0064 * CONTINUATION SECTION :
0065 *****
0066 CONT  NOP
0067     LDA ONE             ASSUME A SUCCESSFUL CALL
0068     STA IFLAG,I
0069     LDA IDL,I           USE BUFFER SIZE AS A COUNTER
0070     CMA,INA
0071     STA CNT3
0072     LDA IDATA          STORE ADDRESS OF DATA BUFFER
0073     STA PTR2
0074     LDB DC             KEEP 600000B IN B-REG
0075     LDA ZERO           INITIATE DATA COUNTER
0076     STA ICNT,I
0077 *
0078 * IF ICODE=3 NO NEED TO TURN OFF OPERATING SYSTEM
0079     LDA ICODE,I
0080     CPA THRE
0081     JMP MORE
0082 *
0083 * TURN OFF OPERATING SYSTEM
0084     JSB $LIBR
0085     NOP
0086 *
0087 * COLLECT DATA TRANSFER WORDS
0088 MORE  NOP
0089     LDA THOU
0090     STA WAIT
0091     OTB LDV
0092     STC LDV,C
0093 LIST  NOP
0094     SFS LDV
0095     JMP IMP
0096     LIA LDV
0097     CPA ZERO           PREVENT ZEROES FROM ENTERING
0098     JMP MORE           BUFFER MEMORY
0099     STA PTR2,I
0100     ISZ PTR2
0101     NOP
0102     ISZ ICNT,I
0103     NOP
0104     ISZ CNT3
0105     JMP MORE
0106 *
0107 * ENABLE THE MEMORY PROTECT FENCE & RETURN
0108 BYE   NOP
0109     CLC LDV
0110     CLF LDV
0111     JSB $LIBX          GO UNPRIVILEGED
0112     DEF ++1           "
0113     DEF ++1           "
0114     JMP DRVR,I
0115 *
0116 * ROUTINE TO WAIT THOU TINES FOR FLAG
0117 IMP   NOP
0118     ISZ WAIT

```

```

0119      JMP LIST
0120      LDA TWO
0121      STA IFLAG,I
0122      CLC LDV
0123      CLF LDV
0124      JSB $LIBX
0125      DEF ++1
0126      DEF ++1
0127      JMP DRV.R,I
0128      *
0129      *
0130      * VARIABLE STORAGE
0131      DC      OCT 60000
0132      K1     DEC 512
0133      ZERO  DEC 0
0134      ONE   DEC 1
0135      TWO   DEC 2
0136      THRE DEC 3
0137      THOU  DEC -32000
0138      CHT1  NOP
0139      CHT2  NOP
0140      CHT3  NOP
0141      PTR1  NOP
0142      PTR2  NOP
0143      WAIT  NOP
0144      END

```

APPENDIX B - MAIN FORTRAN PROGRAM

```

&LDV T=00003 IS ON CR00041 USING 00094 BLKS R=0000

0001 FTN4,L
0002 C-----C
0003 C C
0004 PROGRAM LDV(3,91), REV 930720- TO USE THE LDV
0005 C C
0006 C WRITTEN BY STEVE LUSTIG AND CAROLYN KAPLAN C
0007 C
0008 C-----FUNCTIONS:-----C
0009 C 1) TO TEST THE COINCIDENCE FILTER BOARD C
0010 C 2) TO OPERATE THE DISA LASER DOPPLER ANEMOMETER C
0011 C SYSTEM HARDWARE FROM HP-21MX SOFTWARE C
0012 C 3) TO COLLECT DATA FROM DISA LASER DOPPLER ANEMOMETER C
0013 C BUFFER INTERFACE C
0014 C 4) TO CREATE DISK/TAPE FILES OF THIS DATA C
0015 C 5) TO ASSEMBLE DATA & WRITE OUT ON LP (LU6) C
0016 C 6) TO COMPUTE REYNOLD'S STRESS CORRELATIONS (& ETC) C
0017 C FROM ASSEMBLED DATA C
0018 C C
0019 C---- MISCELLANEOUS-----C
0020 C 1) THE DRIVER OPERATING THE LDV IS CURRENTLY A C
0021 C RELOCATABLE VERSION WHICH IS LOADED WITH THIS PROGRAM. C
0022 C THE VARIABLES PASSED TO THE DRIVER(&DRVR) MUST NOT BE C
0023 C CHANGED. C
0024 C 2) THE LAST WORD IN ARRAY SCW MUST BE THE 'STATIC CONTROL C
0025 C WORD' WHICH IS USED TO 'TURN ON' DESIRED CHANNELS. PRE C
0026 C CEEDING CONTROL WORDS OPERATE PERIPHERAL BOARDS/DEV.S. C
0027 C 3) THE SORTING ROUTINE (MODE=3) WILL MOST LIKELY HAVE TO C
0028 C BE MODIFIED AS MORE HARDWARE IS ADDED TO THE LDV SYS C
0029 C 4) RUNNING THIS PROGRAM WITH THE FTN4,D OPTION WILL ACTI- C
0030 C VATE PRINTING SUBROUTINES IN TASK 3. C
0031 C-----C
0032 C
0033 COMMON LU(5)
0034 INTEGER ISCW(10),IDATA(512),IFLAG,TITLE(20),IDCB(656)
0035 INTEGER TAPELU,ITIME(5),IBUFF(20),IDCB2(144),NAME(3)
0036 INTEGER NAME2(3),PLOC,PARTCH,STIME,ICHT,WAIT
0037 REAL FTI,FTW,FTC,TTI,DT,COUNT,FORM1,FORM2,RDATA
0038 DATA TITLE/40*2H /
0039 C
0040 C-----DETERMINE THE LU OF THE DEVICE-----C
0041 C
0042 CALL RMPAR(LU)
0043 C
0044 C-----DETERMINE TASK-----C
0045 C
0046 2 WRITE(LU,3)
0047 3 FORMAT(1X,'ENTER: 1 TO TEST LDV BY TAKING SAMPLES'
0048 +//17X,'(WRITE TO ANY NON-DISC LU)'
0049 +//11X,'2 TO COLLECT DATA FROM THE LDV INTERFACE'
0050 +//17X,'(COLLECT FOR A GIVEN AMOUNT OF TIME,'
0051 +//17X,'WRITE RAW DATA TO A CREATED DISC FILE)'
0052 +//11X,'3 TO SORT AND ASSEMBLE COLLECTED DATA'
0053 +//17X,'(READ RAW DATA FROM ANY DISC LU,'
0054 +//17X,'ASSEMBLE DATA, WRITE TO DISC FILE)'
0055 +//11X,'4 TO COMPUTE TURBULENCE STRESS CORRELATION'
0056 +//17X,'VALUES FROM ASSEMBLED DATA FILES'
0057 +//11X,'5 TO END THIS PROGRAM'//11X,'_')
0058 READ(LU,*) IMODE

```

```

0059      GO TO (100,200,300,400,9999),IMODE
0060 C
0061      100 CONTINUE
0062 C----TEST THE SYSTEM AND WRITE TO ANY NON-DISC LU-----C
0063 C
0064 C ASK FOR AMOUNT OF DATA AND OUTPUT LU
0065      ISL=0
0066      IDL=512
0067      ICOUNT=0
0068      WRITE(LU,109)
0069      109 FORMAT(' ENTER # DATA WORDS TO COLLECT(<=512)(I5): ')
0070      READ(LU,*)IDL
0071      IF(IDL GT 512)IDL=512
0072      WRITE(LU,130)
0073      130 FORMAT(' ENTER OUTPUT LU(I2): ')
0074      READ(LU,131)IOUT
0075      131 FORMAT(I2)
0076 C
0077 C READ STATIC CONTROL WORDS AND ZERO BUFFER
0078      102 WRITE(LU,103)
0079      103 FORMAT(' ENTER A CONTROL WORD <000000 TO STOP> (06): ')
0080      READ(LU,104)IENTER
0081      104 FORMAT(06)
0082      IF(IENTER.EQ. 00) GO TO 105
0083      ISL=ISL+1
0084      ISCW(ISL)=IENTER
0085      GO TO 102
0086      105 DO 110 I=1,512
0087      110 IDATA(I)=0
0088      IF(ISL.EQ.0) GO TO 2
0089 C
0090      ICODE=3
0091      CALL DRVRC(ICODE, IDATA, ISCW, ISL, ICNT, IFLAG)
0092 C
0093 C WRITE OUT ANY DATA COLLECTED
0094      IF(ICNT.GT.0) WRITE(IOUT,108) (IDATA(I),I=1,ICNT)
0095      108 FORMAT(65(/8(1X,06)))
0096      WRITE(IOUT,120) ICNT, IFLAG
0097      120 FORMAT(' ICNT = ',I3// ' IFLAG = ',I2//)
0098 C
0099 C COLLECTED ENOUGH ?
0100      ICOUNT=ICOUNT+ICNT
0101      IF(ICOUNT.LT.IDL) GO TO 105
0102      GO TO 2
0103 C
0104      200 CONTINUE
0105 C----COLLECT DATA FROM LDV INTERFACE-----C
0106 C SELECTIONS OF STATIC CONTROL WORDS CAN BE ALTERED/STORED HERE C
0107 C FOR ROUTINE DATA COLLECTIONS. THE DISA MANUALS SHOULD BE C
0108 C CONSULTED BEFORE MAKING HARDWARE CHANGES ANY HARDWARE MODI- C
0109 C FICATION WILL PROBABLY RESULT IN THE NEED TO MODIFY CONTROL C
0110 C WORDS. THIS IS A GOOD PLACE TO STORE CONTROL WORDS: C
0111      ISCW(1)=010011B
0112      ISCW(2)=022342B
0113      ISCW(3)=000054B
0114      ISL=3
0115      IDL=512
0116      WAIT=5
0117 C 1. ISCW(1) TURNS ON THE COINCIDENCE FILTER BOARD AND CHANNELS C
0118 C ONE AND TWO. C

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0119 C 2. ISCW(2) SETS A 125 MICROSEC TIME INTERVAL FOR A 0.1 C
0120 C MICROSEC TIME BASE FOR THE COINCIDENCE FILTER BOARD. C
0121 C 3. ISCW(3) SAMPLES BOTH PART CHANNELS OF CHANNELS 1,2 AND 4, C
0122 C CORRESPONDING TO P1,P2 AND P4 ON THE INPUT MULTIPLEXER C
0123 C BOARD. C
0124 C 4. THE DRIVER ASSUMES THAT THE ADDRESS TO DROP REQUEST B IS C
0125 C SET AS 6B (THE SWITCH ON THE 57GXXX BOARD IS ON 6) C
0126 C TAKE DATA CALLING USER WRITTEN DRIVER AND PASS THE FOLLOWING C
0127 C VARIABLES: C
0128 C ICODE : =1 PERFORM INITIATION SECTION OF DRIVER ONLY C
0129 C (CLEAR BUFFER MEMORY AND SEND CONTROL WORDS) C
0130 C =2 PERFORM CONTINUATION SECTION ONLY C
0131 C (COLLECT ANY DATA IN BUFFER MEMORY) C
0132 C =3 DO BOTH SECTIONS WITHOUT RETURNING TO THIS C
0133 C PROGRAM IN BETWEEN C
0134 C IDATA(512) : INTEGER ARRAY OF DATA TRANSFER WORDS COLLECTED C
0135 C IDL : INTEGER NUMBER OF DATA SAMPLES TO COLLECT(<=512) C
0136 C ISCW(10) : INTEGER BUFFER OF CONTROL WORDS TO SEND TO THE C
0137 C 57G20 CONTROL SYSTEM.THE LAST WORD SHOULD BE C
0138 C THE STATIC CONTROL WORD (SCW). C
0139 C ISL : INTEGER NUMBER OF CONTROL WORDS TO BE SENT. C
0140 C ICNT : # OF DATA WORDS COLLECTED BY THE DRIVER C
0141 C (INITIATED AT THE BEGINNING OF EVERY CALL) C
0142 C IFLAG =1 MEANS THAT THE DRIVER COLLECTED DATA NORMALLY. C
0143 C =2 THE DRIVER HAD TO WAIT TOO LONG FOR THE FLAG C
0144 C FLIP-FLOP TO SET WHILE RTE WAS SUSPENDED. C
0145 C NOTE THAT IDATA BUFFER IS NOT CODED ON DISC IN ASCII CHARCTR C
0146 C SET. THUS IT IS IMPOSSIBLE TO SEE THIS DATA W/OUT SOFTWARE. C
0147 C IN ADDITION, THE DATA BUFFER IS NOT ZEROED BETWEEN DRV R CALLS C
0148 C TO SAVE TIME. THIS PROGRAM KNOWS HOW MANY NEW WORDS HAVE BEEN C
0149 C COLLECTED BY THE COUNTER ICNT. THUS ONLY THE FIRST ICNT WORDS C
0150 C IN BUFFER IDATA HAVE BEEN COLLECTED AFTER ANY DRV R CALL! C
0151 C-----C
0152 COUNT=0.0
0153 DATA TITLE/40*2H /
0154 C
0155 C GET INFORMATION FROM USER
0156 WRITE(LU,211)
0157 211 FORMAT(5X,' ENTER CARTRIDGE #, OUTPUT FILE NAME(I2,A6) -')
0158 READ(LU,202) ICR,NAME
0159 202 FORMAT(I2,1X,3A2)
0160 WRITE(LU,204)
0161 204 FORMAT(5X,' ENTER APPROXIMATE TIME IN'
0162 +76X,' SECONDS TO COLLECT DATA(I10): -')
0163 READ(LU,208) STIME
0164 208 FORMAT(I10)
0165 WRITE(LU,209)
0166 209 FORMAT(5X,' ENTER A TITLE(A36)')
0167 READ(LU,210)(TITLE(I),I=2,20)
0168 210 FORMAT(20A2)
0169 C
0170 C CREATE AND OPEN A TYPE 3 SEQ. ACCESS FILE
0171 ISIZE=-1
0172 IOPTH=0
0173 ITYP=3
0174 ISECU=0
0175 IDCBS=640
0176 CALL CREAT(IDCBS,IERR,NAME,ISIZE,ITYP,ISECU,ICR,IDCBS)
0177 IF(IERR.LT.0) CALL ERR(1,IEPR,1)
0178 CALL OPEN(IDCBS,IERR,NAME,IOPTH,ISECU,ICR,IDCBS)

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0179         IF(IERR.LT.0) CALL ERR(2,IERR,2)
0180 C
0181 C WRITE OUT A TITLE
0182         NWORDS=20
0183         CALL WRITF(IDCIB,IERR,TITLE,NWORDS)
0184         IF(IERR.LT.0) CALL ERR(5,IERR,3)
0185 C
0186 C GET STARTING TIME
0187         CALL EXEC(11,ITIME,IYEAR)
0188         FTI=(ITIME(4)*60+ITIME(3))*60+ITIME(2)
0189 C
0190 C COLLECT AND WRITE OUT A BUFFER OF DATA
0191     203 ICODE=1
0192         CALL DRYR(ICODE,IDATA,IDL,ISCM,ISL,ICNT,IFLAG)
0193         CALL EXEC(11,ITIME,IYEAR)
0194         TTU=(ITIME(4)*60+ITIME(3))*60+ITIME(2)
0195     205         CALL EXEC(11,ITIME,IYEAR)
0196                 NTU=WAIT+(ITIME(4)*60+ITIME(3))+ITIME(2)
0197                 IF(NTU.LT.TTU) GO TO 205
0198         ICODE=2
0199         CALL DRYR(ICODE,IDATA,IDL,ISCM,ISL,ICNT,IFLAG)
0200 C
0201 C WRITE BUFFER TO TERMINAL, IF DESIRED
0202 D         IF(ICNT.GT.0) WRITE(LU,108)(IDATA(I),I=1,ICNT)
0203 D         WRITE(LU,120) ICNT,IFLAG
0204 C
0205 C WRITE OUT DATA TO DISC FILE
0206         IF(ICNT.GT.0) CALL WRITF(IDCIB,IERR,IDATA,ICNT)
0207         IF(IERR.LT.0) CALL ERR(5,IERR,5)
0208         COUNT=COUNT+ICNT
0209 C
0210 C CHECK TIME
0211         CALL EXEC(11,ITIME,IYEAR)
0212         TTI=(ITIME(4)*60+ITIME(3))*60+ITIME(2)
0213         DT=TTI-FTI
0214         IF(DT.LT.STIME) GO TO 203
0215         RATE=COUNT/DT
0216 C
0217 C WRITE OUT # SAMPLES AND CLOSE THE DISC FILE
0218         WRITE(LU,207) COUNT,RATE,NAME,ICR
0219     207     FORMAT(10X,' SAMPLING TIME OVER:'
0220             +/10X,G15.3,' DATA WORDS COLLECTED'/7X,' AT ',G15.3,
0221             +' WORDS/SEC'/7X,' ON ',3A2,' ',12//)
0222         CALL LOCF(IDCIB,IERR,IREF,IRB,IOFF,JSEC)
0223         IF(IERR.LT.0) CALL ERR(3,IERR,6)
0224         ITRUN=JSEC/2-IRB-1
0225         CALL CLOSE(IDCIB,IERR,ITRUN)
0226         IF(IERR.LT.0) CALL ERR(4,IERR,7)
0227 C
0228 C GO BACK TO COMMAND SECTION
0229         GO TO 2
0230 C
0231 C-----SORT & REDUCE RAW DATA FILES-----
0232     300 CONTINUE
0233 C
0234 C PREPARE INPUT DISC FILE WITH RAW DATA
0235         IOPTH=0
0236         ITYP=3
0237         ISIZE=-1
0238         ISECU=0

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0239     IDCBS=640
0240     IDCBS2=128
0241     WRITE(LU,304)
0242 304  FORMAT(5X,' ENTER CARTRIDGE # , INPUT FILE NAME [12,A6] _')
0243     READ(LU,202) ICR,NAME
0244     CALL OPEN(IDCBS,IERR,NAME,IOPTH,ISECU,ICR,IDCBS)
0245     IF(IERR.LT.0) CALL ERR(2,IERR,8)
0246 C
0247 C CREATE AND OPEN OUTPUT FILE
0248     WRITE(LU,211)
0249     READ(LU,202) IOUT,NAME2
0250     CALL CREAT(IDCBS2,IERR,NAME2,ISIZE,ITYP,ISECU,IOUT,IDCBS2)
0251     IF(IERR.LT.0) CALL ERR(1,IERR,9)
0252     CALL OPEN(IDCBS2,IERR,NAME2,IOPTH,ISECU,IOUT,IDCBS2)
0253     IF(IERR.LT.0) CALL ERR(2,IERR,10)
0254 C
0255 C WRITE ASSEMBLED DATA TO A NON-DISC LU, IF DESIRED
0256 D     WRITE(LU,305)
0257 D305  FORMAT(5X,' ENTER A NON-DISC LU TO SEE ASSEMBLED DATA: _')
0258 D     READ(LU,131) ILU
0259 D     WRITE(LU,306) ILU
0260 D306  FORMAT(5X,' DO YOU NEED TO CONTROL LU ',12,' ?[Y/N] _')
0261 D     READ(LU,307) IANS
0262 D307  FORMAT(A1)
0263 D     IF(IANS.EQ.1HY) CALL TAPE(ILU)
0264 C
0265 C READ IN TITLE AND WRITE TO OUTPUT FILE
0266     NWORDS=20
0267     CALL READF(IDCBS,IERR,IBUFF,NWORDS,ILEN)
0268     IF(IERR.LT.0) CALL ERR(4,IERR,11)
0269     CALL WRITF(IDCBS2,IERR,IBUFF,NWORDS)
0270     IF(IERR.LT.0) CALL ERR(5,IERR,12)
0271     NCHRS=40
0272     CALL CODE(NCHRS)
0273     READ(IBUFF,210)(TITLE(I),I=1,20)
0274 C
0275 C INITIATE STATISTICAL QUANTITIES, IPASS=1
0276     IPASS=1
0277     CALL STAT(IPASS,ICNTR,RDATA,ITYPE)
0278 C
0279 C CALL FIRST PRINTING ROUTINE, IF DESIRED
0280 D     CALL PRIN1(TITLE,ILU)
0281 C
0282 C READ IN A RECORD OF DATA OF UP TO 512 WORDS
0283     NCHRS=22
0284     NWRDS=11
0285     NWORDS=512
0286     IPASS=2
0287 309  CONTINUE
0288     DO 308 I=1,512
0289 308  IDATA(I)=0
0290     CALL READF(IDCBS,IERR,IDATA,NWORDS,ILEN)
0291     IF(IERR.LT.0) CALL ERR(6,IERR,14)
0292     IF(ILEN.LT.0) GO TO 311
0293 C
0294 C PROCESS THE DATA ON A RECORD
0295     ISKIP=0
0296     DO 310 I=1,ILEN
0297 C
0298 C     ASSEMBLE THE DTW INFORMATION

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0299          CALL ASMBL(IDATA(I),PARTCH,PLOC,FORM1,FORM2,IBO,ITO)
0300 C
0301 C          SORT THE INFORMATION IN THE DTW
0302          CALL SORT(IDATA(I),PARTCH,PLOC,ITYPE,ICNTR,FORM1,FORM2,RDATA)
0303          IF(ITYPE.EQ 6) GO TO 310
0304 C
0305 C          PRINT/WRITE THE DATA, IF DESIRED
0306 C          CALL PRIN2(ICNTR,ITYPE,RDATA,IBO,ITO,ILU)
0307 C
0308 C          DO STATISTICAL SUMMATIONS, IPASS=2
0309          CALL STAT(IPASS,ICNTR,RDATA,ITYPE)
0310 C
0311 C          GROUP VELOCITY & INTRVL DATA (PER BURST) & WRITE TO OUTPUT FILE
0312          CALL GATHR(ISKIP,ICNTR,ITYPE,RDATA,IDCB2)
0313          310 CONTINUE
0314 C
0315 C          READ THE NEXT RECORD IN THE FILE
0316          GO TO 309
0317 C
0318 C          DO FINAL STATISTICAL COMPUTATIONS ON A BUFFER OF DATA, IPASS=3
0319          311 IPASS=3
0320          CALL STAT(IPASS,ICNTR,RDATA,ITYPE)
0321 C
0322 C          CLOSE THE OUTPUT FILE
0323          CALL LOCF(IDCB2,IERR,IREF,IRB,IOFF,JSEC)
0324          IF(IERR.LT.0) CALL ERR(3,IERR,16)
0325          ITRUN=JSEC/2-IRB-1
0326          CALL CLOSE(IDCB2,IERR,ITRUN)
0327          IF(IERR.LT.0) CALL ERR(4,IERR,17)
0328 C
0329 C          PLACE EOF ON ILU IF IT IS A TAPE
0330          ICNWD=ILU+1008
0331          CALL EXEC(3,ICNWD,0)
0332 C
0333 C          RETURN TO COMMAND SECTION
0334          GO TO 2
0335 C-----C
0336          400 CONTINUE
0337 C-----COMPUTE REYNOLDS STRESSES-----C
0338          9999 WRITE(LU,9998)
0339          9998 FORMAT(10X,'**END OF LDV**')
0340          END
0341 C*****C
0342          SUBROUTINE SORT(IDATA,PARTCH,PLOC,ITYPE,ICNTR,FORM1,
0343          +FORM2,RDATA), TO DECIPHER DTW'S
0344          COMMON LU(5)
0345          INTEGER P1234(4),DIGIO(4),MODE(4),PARTCH,PLOC
0346          REAL FSHIFT(4),LAMBDA(4),THETA(4),FORM1,FORM2,TBASE,RDATA
0347 C-----C
0348 C***** NOTICE TO USER MAKING MODIFICATIONS ***** C
0349 C          INDICATE DEVICES CONNECTED TO THE 57G120 INPUT MULTIPLEXER : C
0350 C          THE USER TELLS THIS PROGRAM HOW THE 57G20 CABLES ARE CON- C
0351 C          NECTED BY SETTING THE MEMBERS OF THE FOLLOWING ARRAYS: C
0352 C          P1234(X)=Y WHERE X=1,2,3, OR 4 CORRESPONDING TO PINS C
0353 C          P1,P2,P3,P4 RESPECTIVELY. C
0354 C          Y=1,2 FOR COUNTER WHICH WILL BE REF- C
0355 C          ERENCED AS 1,2 C
0356 C          Y=9 FOR THE COINCIDENCE FILTER BOARD C
0357 C          Y=0 IF NOTHING IS CONNECTED AT ALL C
0358 C          OR FOR THE COINCIDENCE FILTER BOARD C

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0359 C DIGIO(X)=A WHERE X IS THE SAME AS ABOVE C
0360 C A=1 IF THE DIGITAL I/O SLOT #1 CORRES C
0361 C TO PIN X OR A=2 IF DIGITAL I/O SLOT C
0362 C #2 APPLIES. C
0363 C A=0 IF A COUNTER IS NOT CONNECTED C
0364 C FSHIFT(X)=B WHERE X IS THE SAME AS ABOVE C
0365 C B IS THE FREQUENCY SHIFT AS SHOWN ON C
0366 C THE 55N14 FREQ GENERATOR, I E B IS C
0367 C POSITIVE IF THE >40MHZ SIDE IS USED C
0368 C AND NEGATIVE IF <40MHZ B IS ONLY THE C
0369 C VALUE SET ON THE 55N14 PANEL C
0370 C MODE(X)=C WHERE X IS THE SAME AS ABOVE C
0371 C C=1 IF DATA IS COLLECTED IN THE FIXED C
0372 C MODE ON THE COUNTER PROCESSOR, C
0373 C C=2 IF THE COMBINED MODE IS USED, C
0374 C C=3 IF THE VARIABLE FRINGE MODE, AND C
0375 C C=4 IF THE TRANSIT MODE IS USED. C
0376 C C=9 IF NO COUNTER IS ON X. C
0377 C TBASE IS THE FLOATING POINT CLOCK TIME BASE C
0378 C ON JUMPER S2 OF THE CFB. IT MAY BE 0.1 C
0379 C 1, OR 10 USEC. C
0380 C LAMDA(X)=D WHERE X IS THE SAME AS ABOVE C
0381 C D IS THE WAVELENGTH OF LASER EHR USED C
0382 C ON CHANNEL X. C
0383 C THETA(X)=E WHERE X IS THE SAME AS ABOVE. C
0384 C E IS THE ANGLE BETW/ THE CORRES. BEAMS C
0385 C ASSOC W/ THIS COUNTER (FOR COAXIAL C
0386 C BEAMS THIS IS ALWAYS CONSTANT) C
0387 C
0388 DATA P1234/2,1,0,9/
0389 DATA DIGIO/2,2,0,0/
0390 DATA FSHIFT/-10 0E+03,-10.0E+03,0.0,0.0/
0391 DATA MODE/1,1,9,9/
0392 DATA TBASE/0.1E-06/
0393 DATA LAMBDA/ 488.0E-09,514.5E-09,0.0,0.0/
0394 DATA THETA/0.019330253,0.019701965,0.0,0.0/
0395 C
0396 C-----C
0397 C ITYPE IDENTIFIES THE TYPE OF INFORMATION THAT A DATUM GIVES: C
0398 C ITYPE= 1 FOR DOPPLER FREQUENCY DATA C
0399 C 2 FOR SAMPLE INTERVAL DATA, C
0400 C 3 FOR NUMBER OF FRINGES, C
0401 C 4 FOR BURST TIME DATA, C
0402 C 5 FOR VELOCITY DATA, AND C
0403 C 6 I DATA=0 C
0404 C-----C
0405 C
0406 C IDENTIFY THE TYPE OF DATA
0407 ITYPE=DIGIO(PLOC)*PARTCH
0408 IF(ITYPE.EQ.2 AND PARTCH.EQ.1B) ITYPE=3
0409 C SAMPLE INTERVAL HAS ONLY ONE PART CHANNEL OF INFO:
0410 IF(P1234(PLOC) EQ.9 AND PARTCH EQ.1B) ITYPE=2
0411 IF(P1234(PLOC) EQ.9 AND PARTCH EQ.2B) ITYPE=6
0412 IF(I DATA.EQ.0) ITYPE=6
0413 C
0414 C CONVERT DIGITAL OUTPUT TO DOPPLER FREQ, BURST/TRANSIT TIME,
0415 C NUMBER OF FRINGES, OR SAMPLE INTERVAL TIME THIS IS DONE AS
0416 C PRESCRIBED ON P27 OF DISA COUNTER INSTRUCTION MANUAL. ALSO
0417 C SUBTRACT FREQUENCY SHIFTING AND CONVERT TO FREQUENCY TO VELOCITY.
0418 IF(MODE(PLOC) GT.2) GO TO 393

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0419         IF(ITYPE EQ 1) RDATA=FORM1*14.96+FSHIFT(PLOC)
0420         IF(ITYPE EQ 4) RDATA=16.E+09/FORM1+FSHIFT(PLOC)
0421         IF(ITYPE EQ 4) ITYPE=1
0422     353 IF(MODE(PLOC) LE 2) GO TO 354
0423         IF(ITYPE EQ 1) RDATA=0.5348/FORM1+FSHIFT(PLOC)
0424         IF(ITYPE EQ 4) RDATA=0.5E-09*FORM1+FSHIFT(PLOC)
0425         IF(ITYPE EQ 4) ITYPE=1
0426     C CONVERT DOPPLER FREQUENCY TO VELOCITY
0427     354 IF(ITYPE NE 1) GO TO 355
0428     C 0) IF(1 EQ 1) GO TO 355
0429         FACTOR=LAMBDA(PLOC)/(2.*SIN(THETA(PLOC)/2.))
0430         RDATA= RDATA*FACTOR
0431         ITYPE=5
0432     355 IF(ITYPE EQ 2) RDATA= FORM1*TBASE
0433         IF(ITYPE EQ 3) RDATA= FORM2
0434     C
0435     C IDENTIFY WHICH COUNTER
0436         ICNTR=P1234(PLOC)
0437     C
0438     C LEAVE
0439         RETURN
0440         END
0441     C*****
0442     SUBROUTINE GATHR(ISKIP,ICNTR,ITYPE,RDATA,IDCB2), TO GROUP DATA BY
0443     + BURSTS
0444     COMMON LU(5)
0445     DIMENSION Ibuff(33),ITYP(10),ICNT(10),RDAT(10)
0446     IADDR=ICNTR*ITYPE
0447     C
0448     C IF THIS IS THE FIRST CALL, SAVE THE FIRST ADDRESS
0449     IF(ISKIP.EQ.0)GO TO 506
0450     C
0451     C IF IT IS NOT THE FIRST CALL, CHECK TO SEE IF ADDRESS EQUALS
0452     C FIRST ADDRESS
0453     IF(IADDR.NE.IAD)GO TO 522
0454     C
0455     C IF ADDRESS EQUALS FIRST ADDRESS,ZERO THE ARRAY, AND RESET IPTR
0456     521 IPTR=0
0457         DO 508 I=1,3
0458             ITYP(I)=0
0459             ICNT(I)=0
0460             RDAT(I)=0.0
0461     508 CONTINUE
0462     C
0463     C IF DATA IS VELOCITY OR SAMPLE INTERVAL DATA WRITE IN ARRAY
0464     522 IF(ITYPE NE 2 AND ITYPE NE 5) RETURN
0465         IPTR=IPTR+1
0466         ISKIP=1
0467         IDUM=ICNTR
0468         IF(ITYPE EQ 2)IDUM=3
0469         ITYP(IDUM)=ITYPE
0470         ICNT(IDUM)=ICNTR
0471         RDAT(IDUM)=RDATA
0472     C
0473     C IF ARRAY IS FULL, WRITE ARRAY TO BUFFER
0474     IF(IPTR.NE.3) RETURN
0475     CALL CODE(NCHRS)
0476     WRITE(Ibuff,501)(ICNT(IPTR),ITYP(IPTR),RDAT(IPTR),IPTR=1,3)
0477     501 FORMAT(3(1X,I2,1X,I2,1X,G15.8))
0478     C

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0479 C   WRITE DATA IN BUFFER TO OUTPUT FILE & RETURN
0480 C       CALL WRITF(IDC82,IERR,IBUFF,NWRDS)
0481 C       IF(IERR.LT.0)CALL ERR(5,IERR,15)
0482 C       RETURN
0483 C
0484 C   IF FIRST CALL, SAVE FIRST ADDRESS IN VARIABLE IAD, AND
0485 C   THEN ZERO THE BUFFER
0486 C       506 IAD=IADRS
0487 C       NCHRS=66
0488 C       NWRDS=33
0489 C       GO TO 521
0490 C       END
0491 C*****C
0492 C   SUBROUTINE STAT(IPASS,ICNTR,DATA,ITYPE), TO DO STATISTICS
0493 C   COMMON LU(5)
0494 C   REAL MAG,ANGL,SUM1,SUM2,AVG1,AVG2
0495 C   INTEGER N1,N2
0496 C   GO TO (100,200,300),IPASS
0497 C
0498 C   INITIATE QUANTITIES
0499 C   100 CONTINUE
0500 C       N1=0
0501 C       N2=0
0502 C       SUM1=0
0503 C       SUM2=0
0504 C       RETURN
0505 C
0506 C   DO SUMMATIONS, ETC
0507 C   200 CONTINUE
0508 C       IF(ITYPE.NE.5) RETURN
0509 C       IF(ICNTR.NE.1) GO TO 201
0510 C       N1=N1+1
0511 C       SUM1=SUM1+DATA
0512 C       RETURN
0513 C   201 N2=N2+1
0514 C       SUM2=SUM2+DATA
0515 C       RETURN
0516 C
0517 C   FINISH CALCULATIONS
0518 C   300 CONTINUE
0519 C       AVG1=SUM1/N1
0520 C       AVG2=SUM2/N2
0521 C       MAG=SQRT(AVG1*AVG1+AVG2*AVG2)
0522 C       ANGL=ATAN(AVG2/AVG1)
0523 C       ANGL=ANGL*180/3.141592654
0524 C       WRITE(6,301) AVG1,AVG2,MAG,ANGL
0525 C       WRITE(LU,301) AVG1,AVG2,MAG,ANGL
0526 C   301 FORMAT(/// UNWEIGHTED MEAN VELOCITIES:
0527 C   +// <CNTR 1> ',G15.8// <CNTR 2> ',G15.8
0528 C   +// RESULTANT VECTOR: // MAGNITUDE = ',G15.8
0529 C   +// INCLUDED ANGLE = ',G15.8//)
0530 C       RETURN
0531 C       END
0532 C*****C
0533 C   SUBROUTINE ASMBL(DTW,PARTCH,PLOC,FORM1,FORM2,IBO,ITO), ASSEMBLE
0534 C   + DATA FROM DTW'S
0535 C   THE FORMAT OF P,D, & T TYPE DATA:
0536 C   +*****
0537 C   + DTC + 80 CC1 CC2 + M7 E3 E2 + E1 E0 M6 + M5 M4 M3 + M2 N1 M0 +
0538 C   +*****

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0539 C THE FORMAT OF FRINGE DATA:
0540 C *****
0541 C + DTC + B0 CC1 CC2 + F7 F6 + F5 F4 F3 + F2 F1 F0 +
0542 C *****
0543 COMMON LU(5)
0544 INTEGER DTW,PARTCH,PLOC,IBO,ITO,IMAN,IEXP
0545 REAL FORM1,FORM2
0546 PARTCH=IAND(DTW,100000B)/100000B+1B
0547 PLOC=IAND(DTW,030000B)/10000B+1B
0548 IBO=IAND(DTW,40000B)/40000B
0549 ITO=IAND(DTW,4000B)/4000B
0550 IMAN=IAND(DTW,177B)+ITO*200B
0551 IEXP=IAND(DTW,3600B)/200B
0552 FORM1=IMAN*(2.**IEXP)
0553 FORM2=IAND(DTW,3770B)/10B
0554 RETURN
0555 END
0556 C*****C
0557 SUBROUTINE PRIN1(TITLE,ILU), FIRST PRINTING ROUTINE
0558 COMMON LU(5)
0559 INTEGER ISCW(10),TITLE(20),STARS(40)
0560 DATA STARS/2H .39*2H**/
0561 10 WRITE(ILU,11) (TITLE(I),I=1,20),(STARS(I),I=1,40)
0562 11 FORMAT(1H1,20A2/1X,'COUNTER #',
0563 +6X,'PART CHANNEL',15X,'DATA SENT',5X,'OVFLOW BIT',3X,'TIME OUT'
0564 +/40A2)
0565 RETURN
0566 END
0567 C*****C
0568 SUBROUTINE PRIN2(CNTR,ITYPE,RDATA,IBO,ITO,ILU), SECOND PRINT ROUT
0569 +INE
0570 COMMON LU(5)
0571 INTEGER CNTR,PARTCH,IBO,ITO,ALPHA(15,5)
0572 REAL RDATA
0573 DATA ALPHA/2H00,2HPP,2HLE,2HR ,2HFR,2HEQ,2HUE,2HNC,2HY ,6*2H ,
0574 +2HSA,2HMP,2HLE,2H I,2HNT,2HER,2HYA,2HL ,7*2H ,
0575 +2H* ,2HOF,2H F,2HRI,2HNG,2HES,9*2H ,
0576 +2HBU,2HRS,2HT ,2HTI,2HME,10*2H ,
0577 +2HVE,2HLO,2HCI,2HTY,11*2H /
0578 C DO NOT PRINT THE SAME DATUM OVER & OVER
0579 C IF(RDATA.EQ.PDATA) RETURN
0580 C PDATA=RDATA
0581 WRITE(ILU,10) CNTR,(ALPHA(I,ITYPE),I=1,15),RDATA,IBO,ITO
0582 10 FORMAT(5X,11,8X,15A2,615,4,9X,11,8X,11)
0583 RETURN
0584 END
0585 C*****C
0586 SUBROUTINE ERR(IPASS,IERR,ILOC), TO FIND DISC & SOFTWARE ERRORS
0587 C
0588 COMMON LU(5)
0589 C
0590 IF(IPASS.EQ.1) WRITE(LU,1)IERR,ILOC
0591 IF(IPASS.EQ.2) WRITE(LU,2)IERR,ILOC
0592 IF(IPASS.EQ.3) WRITE(LU,3)IERR,ILOC
0593 IF(IPASS.EQ.4) WRITE(LU,4)IERR,ILOC
0594 IF(IPASS.EQ.5) WRITE(LU,5)IERR,ILOC
0595 IF(IPASS.EQ.6) WRITE(LU,6)IERR,ILOC
0596 IF(IERR GE.0) RETURN
0597 STOP
0598 C

```

```

0599 1  FORMAT('<<<CREAT MESSAGE>>IERR= ',I4,' AT ',I2)
0600 2  FORMAT('<<<OPEN  MESSAGE>>IERR= ',I4,' AT ',I2)
0601 3  FORMAT('<<<LOCF  MESSAGE>>IERR= ',I4,' AT ',I2)
0602 4  FORMAT('<<<CLOSE MESSAGE>>IERR= ',I4,' AT ',I2)
0603 5  FORMAT('<<<WRITF MESSAGE>>IERR= ',I4,' AT ',I2)
0604 6  FORMAT('<<<READF MESSAGE>>IERR= ',I4,' AT ',I2)
0605 10 FORMAT('*****TIME OUT ERROR*****'
0606      +/'*****BUFFER OVERFLOW*****',I6)
0607      END
0608 C*****C
0609      SUBROUTINE TAPE(TAPELU), TO CONTROL A TAPE LU BY PROGRAM
0610 C I AM A GEN PURPOSE ROUTINE TO DO NEAT THINGS TO ANY MAG- C
0611 C NETIC TAPE DRIVE. C
0612 C-----C
0613      COMMON LU(5)
0614      INTEGER TAPELU,IBUF(32)
0615      50  WRITE(LU,100) TAPELU
0616 100  FORMAT('-----','ENTER AN OCTAL FUNCTION FOR LU ',I2,' [04]'
0617      +/' 0000 = CLEAR THE DEVICE'
0618      +/' 0100 = WRITE AN EOF'
0619      +/' 0200 = BACKSPACE 1 RECORD'
0620      +/' 0300 = FORWARD SPACE 1 RECORD'
0621      +/' 0400 = REWIND'
0622      +/' 0500 = WRITE AN INTER-RECORD GAP'
0623      +/' 1300 = FORWARD 1 FILE'
0624      +/' 1400 = BACK 1 FILE'
0625      +/' 2700 = LOCATE FILE(CTU ONLY)'
0626      +/' 7777 = READ & LIST A RECORD OF UP TO 32 WORDS'
0627      +/' 1111 = TO GET OUT OF THIS ROUTINE'/'-----')
0628      READ(LU,101) IFC
0629 101  FORMAT(04)
0630      IF(IFC.NE.11118) GO TO 112
0631      WRITE(LU,113)
0632 113  FORMAT(' RETURNING TO MAIN PROGRAM')
0633      RETURN
0634 112  IF(IFC.EQ.27008) GO TO 105
0635      IF(IFC.EQ.77778) GO TO 110
0636      ICODE=3
0637      IOPI=0
0638 103  CALL EXEC(ICODE,TAPELU+IFC,IOPI)
0639      GO TO 50
0640 105  WRITE(LU,106)
0641 106  FORMAT(10X,'ENTER FILE # TO LOCATE [I2]')
0642      READ(LU,*)IOPI
0643      GO TO 103
0644 110  CALL EXEC(1,TAPELU,IBUF,32)
0645      WRITE(LU,111)(IBUF(I),I=1,32)
0646 111  FORMAT(32A2)
0647      GO TO 50
0648      END

```

APPENDIX C - EXAMPLE: SIX cm METHANOL PAN FIRE

REST1 T=00003 IS ON CR00041 USING 00056 BLKS R=0000

0001	6 CM PAN FIRST DATA POINT		
0002	VERTICAL (M)	HORIZONTAL (M)	SAMPLE INT. TIME (SEC)
0003	.14526880	- 21625594E-02	.81100792E-01
0004	.31290054E-02	.43555414E-02	.46202880
0005	.73017776E-02	.57001272E-02	.38174719
0006	-.22369782E-02	.40457380E-03	.23592958
0007	-.22369782E-02	- 71435757E-02	.31948799
0009	.45054266E-02	- 21625594E-02	.69795835
0009	-.91599929E-03	.40457380E-03	.42270720
0010	.63727051E-01	.30249106E-02	.41615355
0011	.16927639	.40457380E-03	.82329601E-01
0012	.16567457	.17079869E-02	.10239999
0013	.17667629E-02	.40457380E-03	.32767999
0014	.31290054E-02	.43555414E-02	.46202880
0015	.31290054E-02	.40457380E-03	.78233600E-01
0016	.45054266E-02	- 21625594E-02	.71434236
0017	.41849620E-03	.40457380E-03	.57671678
0018	.31290054E-02	.17079869E-02	.14581758
0019	.31290054E-02	.17079869E-02	.11796479
0020	.31290054E-02	.17079869E-02	.60293114
0021	.31290054E-02	.40457380E-03	.31293440
0022	.26740372	.40457380E-03	.38830078
0023	.41849620E-03	- 21625594E-02	.64225280
0024	.13424206	- 21625594E-02	.24739838
0025	.57635680E-01	- 88552607E-03	.31743996E-01
0026	.43755323	.30249106E-02	.44236797
0027	.58962824E-02	.43555414E-02	.49479675
0028	.73017776E-02	.30249106E-02	.53084159
0029	-.22369782E-02	.40457380E-03	.17121279
0030	.44725734	.30249106E-02	.50135040
0031	.87221134E-02	.57001272E-02	.41123837
0032	10.004017	.17079869E-02	.63487992E-01
0033	9.1733093	.30249106E-02	.10158080
0034	4.6847963	.40457380E-03	.18022400
0035	14.246948	.40457380E-03	.86425588E-01
0036	13.454493	- 88552607E-03	.10813439
0037	.31290054E-02	.43555414E-02	.62586880
0038	6.5395241	- 88552607E-03	.43212794E-01
0039	4.7763882	.43555414E-02	.32767999
0040	6.6842194	.17079869E-02	.32767999
0041	7.6619654	.17079869E-02	.54886393E-01
0042	10.337299	.30249106E-02	.66764802E-01
0043	.15864873	- 88552607E-03	.49807358
0044	.41849620E-03	.30249106E-02	.19496959
0045	.31290054E-02	.40457380E-03	.83558393
0046	.15522179	.17079869E-02	.50135040
0047	.55655666E-01	- 59169848E-02	.28671998
0048	.73017776E-02	.30249106E-02	.50135040
0049	.59640586E-01	.30249106E-02	.70451200
0050	.41849620E-03	- 21625594E-02	.42270720
0051	.61670892E-01	.17079869E-02	.49807358
0052	.41849620E-03	.30249106E-02	.69468153
0053	-.91599929E-03	- 88552607E-03	.65945596E-01
0054	.58962824E-02	.30249106E-02	.13926399
0055	.99823773	.40457380E-03	.31293440
0056	.15692824	- 88552607E-03	.55705595
0057	.41849620E-03	.40457380E-03	.66846716
0058	.45221126	.40457380E-03	.80936956

0059	.59608161	- .88552607E-03	.12779519
0060	.17667629E-02	.43555414E-02	.54722559
0061	.12525600	.40457380E-03	.33587199
0062	.31290054E-02	.30249106E-02	.40468478
0063	.31290054E-02	.57001272E-02	.38830078
0064	- .22369782E-02	.30249106E-02	.27033597E-01
0065	.31290054E-02	.40457380E-03	.27361280
0066	- .73894039E-02	.17079869E-02	.11960319
0067	- .91599929E-03	.17079869E-02	.74055672
0068	.44725734	.17079869E-02	.71434236
0069	.41849620E-03	.30249106E-02	.33095676
0070	.58962824E-02	.43555414E-02	.24412158
0071	.17667629E-02	.57001272E-02	.61276162
0072	.17667629E-02	.17079869E-02	.54722559
0073	.37129261E-01	.17079869E-02	.11468799
0074	.45054266E-02	.57001272E-02	.64552951
0075	.17667629E-02	.17079869E-02	.29982716
0076	- .91599929E-03	.40457380E-03	.63242233
0077	.45054266E-02	.30249106E-02	.56688643
0078	.63727051E-01	.43555414E-02	.17940480
0079	.41849620E-03	.17079869E-02	.72089601
0080	.31290054E-02	.57001272E-02	.32604158
0081	17.288971	- .88552607E-03	.14335999
0082	5.4457102	.30249106E-02	.14663678
0083	1.5851901	.30249106E-02	.78643203E-01
0084	.45054266E-02	- .88552607E-03	.57343996
0085	.72924316	.40457380E-03	.50790393
0086	- .91599929E-03	- .21625594E-02	.31293440
0087	.16746795	.43555414E-02	.36864001
0088	.61670892E-01	.30249106E-02	.81592309
0089	.45054266E-02	.17079869E-02	.57343996
0090	- .22369782E-02	.30249106E-02	.72089601
0091	.41849620E-03	.40457380E-03	.86835191E-01
0092	.17667629E-02	.17079869E-02	.11468799
0093	.17667629E-02	.40457380E-03	.21135360
0094	.58962824E-02	.57001272E-02	.71106553
0095	.16927639	.70588645E-02	.37847036
0096	.19425631	.17079869E-02	.82903039
0097	.41849620E-03	.30249106E-02	.32358401E-01
0098	.17667629E-02	.30249106E-02	.31129599
0099	- .91599929E-03	- .88552607E-03	.39157760
0100	.12235069	.40457380E-03	.66191351
0101	.16567457	.17079869E-02	.52428794
0102	.31290054E-02	.30249106E-02	.66355199E-01
0103	.31290054E-02	.17079869E-02	.73072636
0104	.17667629E-02	.17079869E-02	.28999680
0105	.41849620E-03	.17079869E-02	.41779196
0106	.41849620E-03	.40457380E-03	.23756799
0107	.45054266E-02	.17079869E-02	.38993919
0108	.41849620E-03	.30249106E-02	.41287678
0109	.17667629E-02	.17079869E-02	.83558393
0110	.37641710	- .88552607E-03	.42926079
0111	.17110023	- .88552607E-03	.68812799
0112	- .22369782E-02	.17079869E-02	.35717118
0113	.63727051E-01	.30249106E-02	.72089598E-01
0114	.35709697	.40457380E-03	.12533760
0115	.13120064	.40457380E-03	.22282240
0116	- .22369782E-02	.40457380E-03	.24248320
0117	.16567457	.17079869E-02	.16629758
0118	.41849620E-03	.17079869E-02	.69468153

0119	.36468273	.30249106E-02	.50462723
0120	.82406759	-.88552607E-03	.12779519
0121	.31290054E-02	.17079869E-02	.15892479
0122	.16213247	-.21625594E-02	.22609919
0123	-.22369782E-02	.40457380E-03	.43008000E-01
0124	.59640586E-01	.17079869E-02	.82247674
0125	.17479461	.43555414E-02	.13107198
0126	.19629845	.57001272E-02	.70778871
0127	.31290054E-02	.17079869E-02	.40468478
0128	.64159811	.43555414E-02	.25559038
0129	.31290054E-02	.70588645E-02	.73400319
0130	.58962824E-02	.70588645E-02	.20479998
0131	.40125716	.40457380E-03	.56360960
0132	.17667629E-02	.30249106E-02	.98303989E-01
0133	.58962824E-02	-.88552607E-03	.19824639
0134	.45054266E-02	.70588645E-02	.46202880
0135	.31290054E-02	.40457380E-03	.44564480
0136	.59640586E-01	.17079869E-02	.27361280
0137	-.13548516E-01	-.10751111E-01	.73728001
0138	.41849620E-03	.30249106E-02	.73728001
0139	.31290054E-02	.57001272E-02	.17694718
0140	.59640586E-01	.17079869E-02	.64225280
0141	-.22369782E-02	.30249106E-02	.83558393
0142	.62205803	.30249106E-02	.15400958
0143	.40558666	-.88552607E-03	.78643191
0144	.31290054E-02	.30249106E-02	.44564480
0145	.45054266E-02	.17079869E-02	.70451200
0146	.41849620E-03	.70588645E-02	.43581438
0147	.41849620E-03	.43555414E-02	.80936956
0148	.41849620E-03	.40457380E-03	.47513598
0149	.31290054E-02	.30249106E-02	.93388796E-01
0150	.87221134E-02	-.88552607E-03	.59310079
0151	.31290054E-02	.43555414E-02	.80936956
0152	.58962824E-02	.30249106E-02	.60293114
0153	-.91599929E-03	.40457380E-03	.36208636
0154	.17667629E-02	.40457380E-03	.15646720
0155	.31290054E-02	.17079869E-02	.11304960
0156	.41849620E-03	-.88552607E-03	.39976960
0157	.17667629E-02	.57001272E-02	.36864001
0158	.44725734	.57001272E-02	.54067194
0159	.73017776E-02	.57001272E-02	.71434236
0160	.31290054E-02	.43555414E-02	.27033597E-01
0161	.12235069	.17079869E-02	.13352960
0162	.31290054E-02	.30249106E-02	.77004790E-01
0163	.65809533E-01	.30249106E-02	.50135040
0164	.15522179	.17079869E-02	.52101111
0165	-.91599929E-03	-.88552607E-03	.78315520
0166	.41849620E-03	-.88552607E-03	.28508157
0167	.73017776E-02	.43555414E-02	.73400319
0168	.45054266E-02	.40457380E-03	.77332473
0169	-.91599929E-03	-.88552607E-03	.10158080
0170	-.91599929E-03	.40457380E-03	.82903039
0171	.84765923	.40457380E-03	.72499201E-01
0172	.38448751	.70588645E-02	.47513598
0173	.41849620E-03	.40457380E-03	.95027193E-01
0174	.59640586E-01	.40457380E-03	.45547515
0175	.73017776E-02	.43555414E-02	.49151999
0176	.61670892E-01	.17079869E-02	.33382401E-01
0177	.41849620E-03	.40457380E-03	.26869756
0178	.66202211	.30249106E-02	.56360960

0179	41849620E-03	- 88552607E-03	.31293440
0180	61670892E-01	.40457380E-03	.45875198
0181	91138351	.40457380E-03	.47513598
0182	31290054E-02	.40457380E-03	.33259517
0183	17110023	.43555414E-02	.24412158
0184	41849620E-03	.43555414E-02	.21954557
0185	45054266E-02	.57001272E-02	.66191351
0186	17667629E-02	.40457380E-03	.16957438
0187	- 91599929E-03	.40457380E-03	.53247996E-01
0188	41849620E-03	17079869E-02	.21299198E-01
0189	17667629E-02	- 88552607E-03	.67502081
0190	45054266E-02	.40457380E-03	.80936956
0191	41849620E-03	.43555414E-02	.22609919
0192	- 61206026E-02	.57001272E-02	.34078717
0193	- 22369782E-02	.30249106E-02	.14499840
0194	- 13548516E-01	.30249106E-02	.69468153
0195	- 91599929E-03	.40457380E-03	.39321595
0196	28436261	.30249106E-02	.64307198E-01
0197	45054266E-02	.43555414E-02	.33751041
0198	- 91599929E-03	.40457380E-03	.11960319
0199	17667629E-02	.17079869E-02	.23592958
0200	59640586E-01	.17079869E-02	.69140470
0201	41849620E-03	.40457380E-03	.90112001E-01
0202	27015656	.30249106E-02	.78315520
0203	17667629E-02	- 88552607E-03	.12779519
0204	98044619E-01	- 21625594E-02	.79953921
0205	59640586E-01	.17079869E-02	.79953921
0206	31290054E-02	.30249106E-02	.72908789E-01
0207			
0208			
0209			
0210			
0211			
0212			
0213			
0214			
0215			
0216			
0217			

UNWEIGHTED MEAN VELOCITIES:

<CNTR 1> .53307307 M/S  
 <CNTR 2> .17951876E-02 M/S

RESULTANT VECTOR:

MAGNITUDE = 0.53307605  
 INCLUDED ANGLE = 0.19294965 FROM VERTICAL

**END**

**FILMED**

**9-84**

**DTIC**