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KELVIN RARE GAS TIME-OF-FLIGHT PROGRAM

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I. Theory and Methods for TOF Calibration.

The purpose of this appendix is to explain in detail the procedure for performing time-of-flight (TOF) calibration measurements. The result of the calibration measurements is to assign a correct length (L) to the path the molecules travel in a particular experimental configuration. In conjunction with time information (t) a velocity distribution (L/t) can then be determined.

To measure the flight path from the interaction zone or TOF wheel to the ionizer a known velocity distribution is used as calibrant. The standard practice is to use the rare gas nozzle distributions which are defined by assuming a Maxwellian velocity distribution superimposed on the bulk flow velocity. Because the electron bombardment ionizer is sensitive to number density, the velocity dependence of the assumed number density distribution is important. From standard texts[1] a Maxwellian velocity distribution is

$$e^{-\frac{M}{2kT_s}(v_x^2 + v_y^2 + v_z^2)} \quad dv_x dv_y dv_z \qquad (1)$$

where T_s is the source temperature. For our model, this is the distribution an observer would see moving at the flow velocity where T_s is the terminal beam temperature (usually $\lesssim 10°K$ for rare gases). However, the observations made in the laboratory frame distort the distribution because of the constraints imposed on the molecular trajectories by the defining apertures.

Let the +z direction be along the beam centerline. For practical measurements the nozzle can be treated as a point source[2a,25] and the detector as a circular disk of radius r at a distance L from the nozzle. The flow velocity is $V_f\hat{Z}$ so the laboratory frame velocity is $V_x\hat{X} + V_y\hat{Y} + (V_z + V_F)\hat{Z}$ where (V_x, V_y, V_z) is the velocity in the mass flow frame of reference. The detector aperture limits the transverse velocity perpendicular to the beam axis by $(V_{transverse})/(V_Z + V_F) \leq \frac{r}{L}$. The laboratory number density distribution of velocities (V_L) is then

$$e^{-\beta V_Z^2} dV_z \int_0^{\frac{r}{L}(V_z+V_F)} e^{-\beta\rho^2} d\rho = e^{-\beta(V_L-V_F)^2} \left(e^{-\beta V_L^2 r^2/L^2} - 1 \right) dV_L \qquad (2)$$

where $\rho = \sqrt{V_x^2 + V_y^2}$, $\beta = \frac{M}{2kT_s}$ and $V_L = V_Z + V_F$. For a standard detector arrangement, $\frac{r}{L} \approx \frac{0.005}{5}$ and the expression (2) can be expanded as

$$e^{-\beta(V_L-V_F)^2} \left(1-\beta V_L^2 \frac{r^2}{L^2} + \frac{\beta^2}{2} \left(\frac{V_L r}{L}\right)^4 + \ldots -1\right) \qquad (3)$$

The speed ratio is defined as $\sqrt{\beta}\ V_F = \alpha$ so (3) becomes

$$e^{-\beta(V_L-V_F)^2} \left(\alpha^2 \left(\frac{V_L}{V_F}\right)^2 \left(\frac{r}{L}\right)^2 - \alpha^4 \left(\frac{V_L}{V_F}\right)^4 \left(\frac{r}{L}\right)^4 + \ldots\right).$$

When the exponential term is maximized $(V_L=V_F)$, the second term in the

power series expansion will be negligible when $\frac{\alpha^2}{2}\left(\frac{V_L}{V_F}\ \frac{r}{L}\right)^2 = \frac{\alpha^2}{2}\left(\frac{r}{L}\right)^2 \leq 0.01$. This holds for typical $\frac{r}{L}$ values when $\alpha \lesssim 100$. For all beams except high pressure He beams or He seeded beams, the speed ratios are usually much less than this value. For speed ratios near 100, the distributions are then sufficiently narrow with respect to the dwell time and ionizer resolution that the width cannot be directly measured with the present flight lengths, so the approximation can be used for all α.

In conclusion, the observed velocity distribution is proportional to

$$V_L^2\, e^{-\beta(V_L-V_F)^2}\, dV_L \tag{4}$$

when $\alpha^2\left(\frac{V_L}{V_F}\right)^2\left(\frac{r}{L}\right)^2 \leq 0.01$. This expression agrees with that derived by Habets[2b] using somewhat different arguments. To compare with the result from the multichannel scaler (MCS) the Jacobian from velocity to time is $dV_L = \frac{V_L^2}{L}\, dt$. The number density distribution experimentally measured is then

$$\frac{V_L^4}{L}\, e^{-\beta(V_L-V_F)^2}\, dt \tag{5}$$

with $V_L = \frac{L}{t}$ and t regarded as the independent variable.

The procedure is to use (4) with known rare gas expansion conditions so that V_F and β can be determined. By using the time location of the observed peak (t_p) in the velocity distribution (4), the effective length L to the ionizer can be determined by $L = V_p{*}t_p$.

The direct output from the MCS can be used to obtain a good first approximation to L. First, the total time offset must be measured. The time offset is given by

$$t_{offset} = t_E - t_{ion} - t_{trigger} + t_D + t_W$$

where t_E is the electronic offset given by the time between the leading edge of the trigger pulse at the MCS trigger input and the maximum of the photodiode signal, t_{ion} is the ion flight time to be described below, $t_{trigger}$ is the width of the trigger pulse sent to the MCS and t_D is a deliberate offset to displace the TOF for long flight paths. t_{wheel} is the time delay resulting from the offset between the peak of the photodiode signal and when the wheel slit is centered on the detector slit. t_{wheel} is measured by rotating the wheel clockwise and counterclockwise and averaging the two results. The $t_{trigger}$ delay results from the design of MCS. The 1 MHz internal clock is disabled for the duration of the trigger pulse, so the clock begins to decrement the dwell time counter within 50 nsecs after the <u>end</u> of the trigger pulse. The ion flight time is determined by measuring the difference in mass peaks originating from a common molecule. The use of multiply charged rare gas ions has been observed to result in incorrect (over-estimation) of ion flight times. D. Krajnovich has used CF_3I in He to obtain narrow velocity distributions with mass fragments over a large range. The possible source of error in this method is the translational

energy released in fragmentation which could distort the measurement. A comparison of the fragment distribution widths will indicate if this is important. The various mass fragment peaks can be used to fit the expression $C\sqrt{M}$. For 75 volt ions and 250 volt extraction voltage the canonical value for C is 3 μsecs/$\sqrt{\text{amu}}$.

The predicted maximum velocity from eqn. (5) is

$$V_P = \frac{V_F}{2} + \frac{V_F}{2}\sqrt{1 + \frac{4}{\beta V_F^2}} \quad \text{or} \quad V_F = \frac{V_P^2 - 1.0/\beta}{V_P} \qquad (6)$$

where

$$V_F\ (\text{cm/sec}) = 2.039 \times 10^4 \sqrt{\frac{T_{nozzle}(^\circ K) - T_{terminal}(^\circ K)}{M(\text{amu})}} .$$

The nozzle temperature is measured with a thermocouple using an ice bath reference. The terminal temperature is obtained from the half width of the velocity distribution by

$$T_{terminal}(^\circ K) = 8.679 \times 10^{-9}\ m(\text{amu})\ (\Delta v(\text{cm/sec}))^2 \qquad (7)$$

where

$$\Delta v = \frac{L * \Delta t}{t_{1/2} * t_0 * t_{Dwell}} .$$

L is the flight length to be determined and can be guessed by previous

knowledge for an initial correction. Δt is the number of channels between the maximum and half height of the distribution, $t'_{1/2}$ is the half height channel number corrected for the offset time, t'_o is the peak channel number corrected for the offset time, and t_D is the dwell time. Using these values $L(cm) = V_P(cm/sec) * t'_o(sec)$. The agreement between L values determined from Ar, Kr, Xe expansions should be ± 0.3%.

To compare the accuracy of this direct method the more accurate fitting by the KELVIN program was used to iterate on $T_{terminal}$ and L until agreement was found. The results are reported in Table 1.

The source of errors which can bias the above procedure which are within experimental control are the purity of rare gas used for calibration and the count rate limitations of the MCS. The first effect can be quite noticeable because several minutes after flowing a new rare gas it is still possible to detect a clean TOF at the preceeding mass. The experimentalist should wait until all traces of the old gas disappear. Gas cylinders can contain impurities when they are low in pressure. A cursory mass scan at atmospheric and rare gas peaks during the purge time can check for this source of contamination.

The second effect cannot be solved by using the average observed count rate on the count rate meter, since most of the signal is arriving in a small time interval, roughly 1/200 of the rate meter duty cycle. The MCS scalers are rated at ~30 MHz with a minimum data pulse width of 20 nanoseconds. For 1% accuracy in the largest channel the count rate should not exceed 1 MHz.

An additional source of bias was though to be the manner in which the dual scalers toggle back and forth as the channels advance. If a data pulse is present at the transiton from one channel to the next, then depending on its width four alternatives are possible. First, if the data pulse is short, then the partial pulse transmitted to either scaler will be too short to trigger the counters. Conversely, if each portion is sufficiently long then the pulse will be counted twice. The intermediate range is when one half of the pulse is sufficient and the other not to trigger the corresponding counter. These effects were empirically investigated using a digital delay generator/pulse generator arrangement to measure the delay between a single data pulse relative to the trigger pulse with an accuracy of 10 nanoseconds. The results are shown in Fig. 1. From these measurements it is seen that for pulse widths greater than 30 nanseconds, the multiple counting dominates. However, the effect of the problem is not significant except for very large total counts. The reason for this is as follows.

Assume the data in channels i, i+1 is fit by a linear equation to be determined below. If C_i, C_{i+1} are the total counts in these channels, then

$$Y = \frac{(C_{i+1} + C_i)}{2t_i t_d} X + \frac{C_{i+1} + C_i}{2t_D} + \frac{(C_i - C_{i+1})t_i}{t_D^2}$$

where t_i is the ith channel time, t_D the dwell time, and

$$C_{i+1} = \int_{t_i}^{t_{i+1}} y dx; \qquad C_i = \int_{t_{i-1}}^{t_i} y dx.$$

The number of counts centered about the channel transition in a time interval 2Δ is

$$\int_{t_i-\Delta}^{t_i+\Delta} y dx = \frac{\Delta}{t_p}\frac{(C_{i+1} + C_i)}{2} \equiv \frac{\Delta}{t_p} \bar{N}.$$

Consequently, for Δ = 30 nanoseconds, t_D = 2 microseconds the correction is 4.5×10^{-3} $\bar{N}$ where 30% overcounting has been assumed. This compares with the statistical error $\sqrt{\bar{N}} = \bar{N} * 4.5 \times 10^{-3}$ when $N = 5 \times 10^5$ counts. With longer dwell times the effect is even less important.

The behavior on the 1 microsecond dwell time scale is not nearly as good as the 2 microsecond results and should be avoided. The data presented here refers to one particular MCS unit and may not be transferable to other units.

The imperfect gas correction to the enthalpy for Ar at 1000 torr, 288°K amounts to ~-0.2%[2b] and can be neglected here in determining V_o (Eqn. 6) from the nozzle temperature. Condensation effects will perturb the terminal temperature and velocity by the heat of condensation added to the flow and by ionizer fragmentation to the monomer mass. This can be checked by observing higher polymer masses, and lowering the pressure if necessary.

Several studies[2b] have shown that a two component velocity distribution gives a much improved fit to the data. This was not investigated but the systematic differences observed in the calculated and experimental data here are similar to those reported by the above studies using a one component distribution. For chemical accuracy, the one component fit is adequate.

The assumption of the one component distribution was tested indirectly by attempting a direct deconvolution of the measured distribution. For every channel, a narrow velocity distribution ($\beta = 10^6$) centered on that channel was convoluted over the ionizer and shutter functions. The spread of this "delta function" input into adjacent channels defines a matrix C which takes the true channel distribution into the observed one. The inverse of this matrix $C^{-1} = D$ will then relate the observed channel space distribution to the true distribution free of ionizer and shutter effects. This deconvoluted distribution can then be transferred simply to a velocity distribution. In Fig. 2 is shown the results for two rather different expansions, a high pressure He beam and a He/N_2 anti-seeded beam. The high pressure beam shows that the distribution is completely contained within the convolution effects. The large oscillations are a result of the narrow distribution and the change in sign of adjacent entries of the inverse matrix, D. A simple two channel average removes this effect noticeably. The anti-seeded distribution shows no significant difference between the measured and deconvoluted results. This is a consequence of the broadness of the distribution. The direct deconvolution

result is not as useful as the trial and fit method because the information is not as compact as the simple two parameter fit. It is useful as a guide to the magnitude of the broadening induced by the measurements.

For laser photofragmentation experiments the distance from the collision zone to the TOF wheel must be added onto the TOF distance. This is done by measuring the distance with the transit while the wheel is spinning to reduce the warp error caused by the 5 mil stainless steel wheel material.

The effect of emission current and extractor voltage effect the modeling of the detection process by a nonuniform electron distribution which can shield the ions from the extraction field or ionize the neutral species nonuniformly. These can be experimentally measured by using a narrow He beam whose experimental width is dominated by the ionizer. Until this behavior is known, a more accurate deconvolution of the TOF spectra is not warranted.

REFERENCES

1. F. Reif, Fundamentals of Statistical and Thermal Physics, p. 264, McGraw-Hill (1965).

2. (a) U. Bossel, R. David, M. Faubel, K. Winkelmann, Rarfied Gas Dynamics, p. 235.

   (b) A. Habets, "Supersonic Expansion of Argon into Vacuum", Ch. 2,5 Thesis, University of Eindhoven, Holland, 1977.

Table 1. Comparison of computer fitted parameters with those obtained by iteratively solving Equations 6,7 in the text.

	Computer Fit			Iterative Fit					
				First Iteration			Second Iteration		
	L(cm)	β	V_0(10^4 cm/sec)	L	β	V_0	L	β	V_0
Ar	16.46	2.751	5.517	16.75	2.662	5.616	16.544	2.740	5.536
Kr	16.46	5.136	3.807	16.75	4.970	3.875	16.512	5.115	3.820
Xe	16.46	8.111	3.058	16.75	7.838	3.113	16.477	8.067	3.068

FIGURE CAPTIONS

Fig. 1. Transition effects in the dual scalers (a) 25 nanosecond data pulse width, 2 microsecond dwell time. (b) 40 nanosecond data pulse width, 2 microsecond dwell time. (c) 50 nanosecond data pulse width, 2 microsecond dwell time. (d) 40 nanosecond data pulse width, 3 microsecond dwell time. ▲ total counts in channels 10 and 11. ■ total counts in channel 10. ● total counts in channel 11.

Fig. 2. (a) Deconvoluted He beam. — Initial data. ● Deconvoluted data. △ Deconvoluted with 2 channel average.
(b) Deconvoluted He/N_2 beam. ● Initial data. △ Deconvoluted data (displaced by one channel).

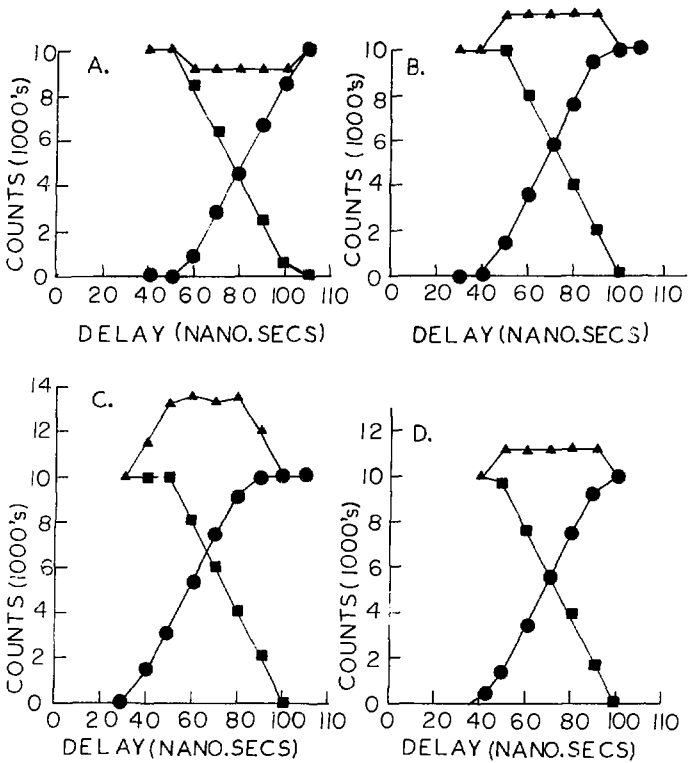

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Fig. 1

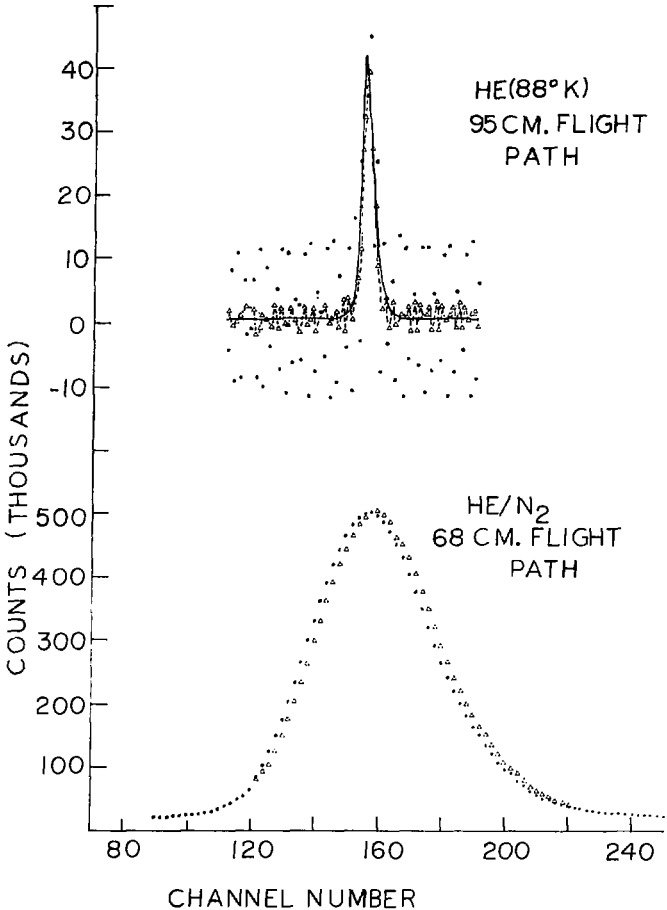

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Fig. 2

II. Time of Flight Program KELVIN and Directions for use.

This section describes the salient featues of the program KELVIN used to fit time of flight data to deduce velocity distributions. The current version draws heavily on its predecessor written by J. Valentini. Its basic difference is to improve efficiency in the calculation by using a digital filter devised by R. Sparks. It also has an improved search procedure to find the best fit parameters.

The nominal structure is to simulate the effects of the finite ionizer length and slit widths on a measured velocity distribution by calculating a shutter function for the channel space slit overlap which is used as a digital filter. This is applied to the trial velocity distribution which has been convoluted for the ionizer length. The ionizer is treated as a simple sum of 10 identical point ionizers with slightly different lengths from the collision zone. Using a Marquardt algorithm. the parameters are varied until one of three criteria is satisfied.

1) The change in parameters is less than 0.005 of their respective magnitudes.
2) The value of X^2 has reached a value such that the data has been fit to the 90% confidence limit.
3) Twenty complete iterations have occurred without either 1) or 2) occurring.

KELVIN can analyze any number of time of flights. Each velocity distribution needs the same number of input cards. The final data set

is followed by a blank card. To use the program which is stored on disk, use the following control cards.

```
JOBCARD
USER PR
FETCHPS, VDW, LGO/RR, KELOBJ.
LGO.
EXIT.
DUMP, 0.
GRUMP.
7/8/9
```

Input cards needed for each velocity distribution (all numbers F10.1 format, except where noted).

Card

1. Title
2. Mass (amu), channel width (μ sec), nominal neutral flight length (cm), ionizer length (cm), channel offset (channels).
3. Beginning channel number, ending channel number (2I5).
4. Wheel frequency (Hz), wheel diameter (cm), wheel slit width (mm), collimating slit width (mm).
5. etc. Data (8F10.1)

Output consists of the title with a list of the parameters used, followed by the input data, and the shutter function in channel space. Offset has the opposite effect from the ion flight time, i.e. offset is directly added to the channel number.

The intermediate reduced standard deviations and parameter changes are listed with each iteration.

The final parameters are listed along with the number of iterations, calculated data, and the change in the fitted parameters that would produce a X^2 greater than at the minimum.

A graph of the two distributions is also produced.

The parametrized velocity distribution has the form

$$P(v) \sim v^2 e^{-\beta(v-v_o)^2}$$

where v_o is the mass flow velocity, and $\beta = 1/(\mathrm{ALPHA})^2$, where alpha is the average relative velocity in the mass flow frame of reference. The speed ratio is the dimensionless number $\sqrt{\beta} * v_o$. The flow velocity is in units of 10,000 cm/sec.

```
      PROGRAM KELVIN(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
      COMMON/PAR/CHAN,LMID,DL,BCHAN,ECHAN,NCHAN,MASS,MAXF,OFFSET
      COMMON/TRIP/WIDTH,HZ,DIA,SA,SD,TRP(19),ITRSIZ,ITRSHF,IFLAG
      DIMENSION EXPT(255),SIGCAL(255),SIGCA1(255),SIGCA2(255)
      DIMENSION YPL1(256),YPL2(256),XPL(256)
      REAL MASS,LMID
      INTEGER BCHAN,ECHAN,NCHAN
C
C     INPUT DATA
C
 1003 CALL INDATA(EXPT,BETA,VZRO)
C
C      FITTING ROUTINE TAKEN FROM 'DATA REDUCTION AND ERROR ANALYSIS
C      FOR THE PHYSICAL SCIENCES' BY PHILIP R. BEVINGTON.
C      PROGRAM 11-5 CURFIT WHICH IS A MARQUARDT ALGORITHM FOR  A NON-
C      LINEAR LEAST SQUARES FIT WITH IMPROVED STABILITY NEAR A MINIMUM
C      WAS THE MODEL FOR THIS PROCEDURE.
C      ALL CALCULATIONS ARE PERFORMED WITH VZRO IN KILOMETERS PER SECOND.
C      OUTPUT IS IN UNITS OF 10**4 CM/SEC
C
C
C      CALCULATE FIRST ATTEMPT AT A FIT WITH TRIAL VALUES.
C
      SF=0.
      CALL VELO(BETA,VZRO,SIGCAL,SIGCA1,SIGCA2)
      CALL FIT1(SIGCAL,EXPT,SF,DC)
      ILOW=BCHAN+ITRSHF
      IHIGH=ECHAN-ITRSHF
      IFIT=10
      FLAMDA=.001
      CN=FLOAT(NCHAN-4-2*ITRSHF)
      WRITE(6,300)
  300 FORMAT(1X,*INTERMEDIATE VALUES*,/)
      DO 1000 JCYC=1,IFIT
C
C      DFDV IS THE FIRST DERIVATIVE WITH RESPECT TO PEAK VELOCITY.
C      DFDB IS THE FIRST DERIVATIVE WITH RESPECT TO PEAK WIDTH.
C
C      W IS THE WEIGHTING FACTOR.
C      B1 AND B2 IS THE BETA MATRIX.
C      A11,A12,A22 IS THE ALPHA MATRIX
C
      B1=0.
      B2=0.
      A11=0.
      A12=0.
      A22=0.
      SUM=0.
C
C     DO LOOP ONLY EXTENDS OVER CHANNELS WHICH ARENT TRUNCATED BY THE
C     SHUTTER FUNCTION.
C
      DO 1001 I=ILOW,IHIGH
      DFDB=SIGCA2(I)*SF
      DFDV=SIGCAL(I)*SF
```

```
      W=1./EXPT(I)
      D=EXPT(I)-SIGCAL(I)
      DW=D*W
      B1=B1+ DW*DFDV
      B2=B2+ DW*DFDB
      A11=A11+DFDV*DFDV*W
      A22=A22+DFDB*DFDB*W
      A12=A12+DFDV*DFDB*W
 1001 SUM=SUM+D*DW
C
C     CALCULATE THE CHI SQUARED ERROR.
C      NOTE THAT THERE ARE FOUR PARAMETERS IN THE FIT TO THE DATA,
C     THESE ARE THE  ΣI LEVEL, THE SCALE FACTOR, THE PEAK WIDTH AND
C     VELOCITY.
C
      CHI1=SUM/CH
C
C     ADJUST PARAMETERS AS NECESSARY
C      A1 AND A2 IS THE CURVATURE MATRIX. A1NV AND A2NV ITS INVERSE.
C      FLAMDA IS THE FACTOR WHICH DETERMINES THE EXTENT OF THE GRADIENT
C      INFLUENCE ON THE SEARCH.
C
   71 A1=1.+FLAMDA
      DEN2=SQRT(A11*A22)
      A2=A12/DEN2
      DEN1=A1*A1-A2*A2
      A1NV=A1/DEN1
      A2NV=-A2/DEN1
      DVZRO=B1*A1NV/ABS(A11)+B2*A2NV/DEN2
      DBETA=B1*A2NV/DEN2          +B2*A1NV/ABS(A22)
C
C     IF BETA IS FORCED TO GO NEGATIVE, THEN THE DISTRIBUTION IS
C     NARROW RELATIVE TO THE SHUTTER FUNCTION. DBETA IS HALVED UNTIL
C     THE VALUE OF BETA IS POSITIVE. IFLAG IS SET TO 1 SINCE THE MORE
C     ACCURATE INTEGRATION OVER THE CHANNEL WIDTH IS NECESSARY FOR THIS
C     CASE.
C
  221 IF(BETA+DBETA)225,225,210
  225 IFLAG=1
      DBETA=DBETA/2.
      GOTO 221
C
C     CALCULATE THE DISTRIBUTION AT THE NEW VALUE OF BETA AND VZRO.
C
   2. F=0.
      CALL VELO(BETA+DBETA,VZRO+DVZRO,SIGCAL,SIGCA1,SIGCA2)
      CALL FIT(SIGCAL,EXPT,SF,QC)
      SUM=0.
      DO 1010 I=ILOW,IHIGH
 1010 SUM=SUM+(EXPT(I)-SIGCAL(I))**2/EXPT(I)
      CHI2=SUM/CH
      WRITE(6,216) CHI2,DBETA/103.,DVZRO*10.
  216 FORMAT(5X,*STANDARD DEVIATION=*,E13.3,5X,*DBETA=*,E12.4,5X,*DVZRO=
     1*,E12.4)
C
```

```
C     IF THE NEW VALUE OF CHISQR, IS LARGER THAN THE  OLD VALUE, MAKE
C     THE GRADIENT CONTRIBUTION 10 TIMES LARGER AND TRY AGAIN.
C
      IF(CHI1-CH2) 95,101,101
   95 FLAMDA=10.*FLAMDA
      GOTO 71
C
C     STOP FITTING IF PARAMETERS OPTIMIZED
C
C     A IS THE NUMBER OF STANDARD DEVIATIONS EACH CALCULATED POINT
C     DIFFERS FROM THE DATA ON THE AVERAGE
C
  101 A=SQRT(SUM/FLOAT(NCHAN-2*ITRSHF))
      VZRO=VZRO+DVZRO
      BETA=BETA+DBETA
      FLAMDA=FLAMDA/10.
C
C     THE SEARCH ENDS IF 10 ITERATIONS HAVE HAPPENED WITHOUT THE
C     FOLLOWING CONDITIONS HAVING BEEN SATISFIED.
C     IF THE VALUES OF  BETA AND VZRO ARE CHANGING LESS THAN .005
C     OF THEIR PREVIOUS VALUE, OR THE DATA HAS BEEN FIT WITHIN THE 90
C     PER CENT CONFIDENCE LIMIT, I.E. A<2.
C
      IF(A.LE.2.) GOTO 1002
      IF((ABS(DBETA).LE.(.005*BETA)).AND.(ABS(DVZRO).LE.(.005*VZRO)))
     1 GOTO 1002
 1000 CONTINUE
      JCYC=JCYC-1
 1002 WRITE(6,301)
  301 FORMAT(/,1X,*FINAL PARAMETER VALUES*,/)
      WRITE(6,1210)BETA/100.,VZRO*10.,V230*SQRT(BETA)*10./SQRT(BETA),
     1JCYC,A
 1210 FORMAT(1X,*BETA=*,E12.4,3X,*VZRO=*,E12.4,2X,*SPEED RATIO=*,E12.4,
     12X,*ALPHA=*,E12.4,2X,*ITERATIONS=*,I3,2X,*AVERAGE DEVIATION=*,F4.1
     1)
      IF(JCYC.EQ.IFIT) WRITE(6,219)
  219 FORMAT(5X,*C A U T I O N---- THE FULL NUMBER OF ITERATIONS HAS
     1OCCURED WITHOUT CONVERGENCE*,/)
      EBETA=SQRT(A2HV/A22)
      EVZRO=SQRT(ALNV/A11)
      WRITE(6 217) EBETA/100.,EVZRO*10.
  217 FORMAT(* ESTIMATED ERROR IN LOCATION OF MINIUM IN SURFACE IN BETA
     1 AND VZRO=*,E12.4,5X,E12.4)
C
C     PLOT DATA
C
      WRITE(6,205)
      NPTS=NCHAN-NCHAN-2*ITRSHF
      XSTEP=5./FLOAT(NPTS)
      J=1
      OC=EXPT(NCHAN+3)
      XPL(1)=0.
      TT=9.9/(EXPT(MAXE)-OC)
      WRITE(6,206)(I,SIGCAL(I),I=ILOW,IHIGH)
      DO 1005 I=ILOW,IHIGH
```

```
                YPL1(J)=(EXPT(I)-DC)*TT
                YPL2(J)=(SIGCAL(I)-DC)*TT
                J=J+1
                XPL(J)=XPL(J-1)+XSTEP
 170      1005 CONTINUE
                CALL LPPLT(XPL,YPL1,NPTS,XPL,YPL2,NPTS,1)
          205 FORMAT(//,10X,"C A L C U L A T E D  D I S T R I B U T I O N",/)
          206 FORMAT(8(1X,I3,1X,F9.1))
              GO TO 1003
 175          END


SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
 1123  KELVIN

VARIABLES    SN  TYPE        RELOCATION
 1700  A          REAL                  1667  A1         REAL
 1673  AINV       REAL                  1656  A11        REAL
 1655  A12        REAL                  1671  A2         REAL
 1674  A2NV       REAL                  1656  A22        REAL
    3  BCHAN      INTEGER      PAR      1640  BETA       REAL
 1652  B1         REAL                  1653  B2         REAL
 1650  CH         REAL                     0  CHAN       REAL          PAR
 1666  CH11       REAL                  1677  CH12       REAL
 1664  D          REAL                  1676  DBETA      REAL
 1663  DC         REAL                  1672  DEN1       REAL
 1670  DEN2       REAL                  1661  DFDB       REAL
 1662  DFDV       REAL                     2  DIA        REAL          TRIP
    2  DL         REAL         PAR      1675  DVZRO      REAL
 1665  DW         REAL                  1701  EBETA      REAL
    4  ECHAN      INTEGER      PAR      1702  EVZRO      REAL
 1707  EXPT       REAL         ARRAY    1647  FLAMDA     REAL
    1  HZ         REAL         TRIP     1660  I          INTEGER
 1646  IFIT       INTEGER                 32  IFLAG      INTEGER       TRIP
 1645  IHIGH      INTEGER                1644  ILOW       INTEGER
   31  ITRSHF     INTEGER      TRIP       30  ITRSIZ     INTEGER       TRIP
 1705  J          INTEGER                1651  JCYC       INTEGER
    1  LMID       REAL         PAR         6  MASS       REAL          PAR
    7  MAXE       INTEGER      PAR         5  NCHAN      INTEGER       PAR
 1703  NPTS       INTEGER                 13  OFFSET     REAL          PAR
    3  SA         REAL         TRIP        4  SD         REAL          TRIP
 1662  SF         REAL                  2306  SIGCAL     REAL     ARRAY
 2705  SIGCA1     REAL         ARRAY    3304  SIGCA2     REAL     ARRAY
 1657  SUM        REAL                     5  TRP        REAL     ARRAY TRIP
 1704  TT         REAL                  1661  VZRO       REAL
 1663  W          REAL                     0  WIDTH      REAL          TRIP
 4703  XPL        REAL         ARRAY    1706  XSTEP      REAL
 3703  YPL1       REAL         ARRAY    4303  YPL2       REAL     ARRAY
```

```
FILE NAMES        MODE
    0  INPUT                    445  OUTPUT                    0  TAPES                    445  TAPE6     FMT

EXTERNALS          TYPE   ARGS
       FTP                  4                                  INDATA                 3
       LPPLT                7                                  SQRT      REAL         1  LIBRARY
       VELO                 5

INLINE FUNCTIONS   TYPE   ARGS
       ABS         REAL     1  INTRIN                          FLOAT     REAL         1  INTRIN

STATEMENT LABELS
 1207  71                                   0  95          INACTIVE                 1764  101
 1614  205     FMT                     1623  206     FMT                          1476  216     FMT
 1570  217     FMT                     1550  219     FMT                          1293  223
 1229  221                                 0  225         INACTIVE                 1464  300     FMT
 1511  301     FMT                         0  1003                                    3  1001
 1312  1002                             1127  1033                                    0  1005
    0  1010                             1527  1210    FMT

LOOPS  LABEL    INDEX      FROM-TO    LENGTH    PROPERTIES
 1150  1000     JCYC        34 137      1408        EXT REFS    EXITS   NOT INNER
 1155  1001     I           53 64        218        OPT
 1245  1010     I          104 105        38     INSTACK
 1366           I          164 166        78            EXT REFS
 1402  1005     I          165 170        58     INSTACK

COMMON BLOCKS    LENGTH
       PAR            9
       TRI           27

STATISTICS
  PROGRAM LENGTH                44158   2317
  BUFFER LENGTH                  6660    438
  SCM LABELED COMMON LENGTH       448     36
          61000B SCM USED
```

```
      SUBROUTINE FIT(SIGCAL,EXPT,SCALE,DC)
C
C     SCALES THE CALCULATED AND OBSERVED TOF SPECTRA
C
      DIMENSION SIGCAL(255),EXPT(255)
      COMMON/TRIP/WIDTH,HZ,DIA,SA,SB,TRP(19),ITRSIZ,ITRSHF,IFLAG
      COMMON/PAR/CHAN,LMID,DL,BCHAN,ECHAN,NCHAN,MASS,MAKE,OFFSET
      INTEGER BCHAN,ECHAN
      ILOW=BCHAN+ITRSHF
      IHIGH=ECHAN-ITRSHF
      RCHAN=0.
      XINV=0.
      X=0.
      Y=0.
      YX=0.
      YYX=0.
C
C      LEAST SQUARES LOOP
C
      DO 30 I=ILOW,IHIGH
      Y=Y+SIGCAL(I)
      XINV=XINV+1./EXPT(I)
      YX=YX+SIGCAL(I)/EXPT(I)
      YYX=YYX+SIGCAL(I)*SIGCAL(I)/EXPT(I)
      RCHAN=RCHAN+I.
      X=X+EXPT(I)
   30 CONTINUE
      DELTA=XINV*YYX-YX*YX
      DC=(RCHAN*YYX-YX*Y )/DELTA
      SCALE=(XINV*Y-RCHAN*YX)/DELTA
C
C      FINALLY SCALE THE DATA
C
      DO 40 I=BCHAN,ECHAN
      SIGCAL(I)=SIGCAL(I)*SCALE+DC
   40 CONTINUE
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 FIT

VARIABLES		SN	TYPE	RELOCATION					
3	BCHAN		INTEGER	PAR	0	CHAN	REAL		PAR
0	DC		REAL	F.P.	56	DELTA	REAL		
2	DIA		REAL	TRIP	2	DL	REAL		PAR
4	ECHAM		INTEGER	PAR	0	EXPT	REAL	ARRAY	F.P.
1	HZ		REAL	TRIP	55	I	INTEGER		
32	IFLAG		INTEGER	TRIP	46	IHIGH	INTEGER		

```
VARIABLES     SN  TYPE              RELOCATION
   45  ILON       INTEGER                          33  IRESHF     INTEGER          TRIP
   30  ITRSIZ     INTEGER              TRIP        1  LMID       INTEGER          PAR
    6  MASS       INTEGER              PAR         7  MAXE       INTEGER          PAR
    5  NCHAN      INTEGER              PAR        10  OFFSET     REAL             PAR
   47  RCHAN      REAL                             3  SA         REAL             TRIP
    4  SA         REAL                 TRIP        0  SCALE      REAL              F.P.
    0  SIGCAL     REAL       ARRAY      F.P.       5  TRP        REAL       ARRAY  TRIP
    0  WIDTH      REAL                 TRIP       51  X          REAL
   50  XINV       REAL                            52  Y          REAL
   53  YX         REAL                            54  YYX        REAL

STATEMENT LABELS
    0  30                                  0  40

LOOPS  LABEL  INDEX     FROM-TO    LENGTH   PROPERTIES
   19  30     I         20 27       128     INSTACK
   41  40     I         34 36        38     INSTACK

COMMON BLOCKS   LENGTH
      TRIP        27
      PAR          9

STATISTICS
  PROGRAM LENGTH                   576      47
  SCM LABELED COMMON LENGTH        448      36
        010008 SCM USED
```

```
      SUBROUTINE BIG(SIGCAL,MAX)
C
C     FINDS THE MAXIMUM IN A TOF SPECTRUM
C
      COMMON/PAR/CHAN,LMID,DL,BCHAN,ECHAN,NCHAN,MASS,MAXE,OFFSET
      INTEGER BCHAN,ECHAN
      DIMENSION SIGCAL(255)
      MAX=0
      SIGMAX=0.0
      DO 1 I=BCHAN,ECHAN
      IF (SIGCAL(I) .LT. SIGMAX) GO TO 1
      SIGMAX=SIGCAL(I)
      MAX=I
    1 CONTINUE
      IF(MAX .EQ. 0) WRITE (6,255)
  255 FORMAT(*0  NO MAXIMUM FOUND*)
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

```
ENTRY POINTS
    3 BIG

VARIABLES     SN  TYPE        RELOCATION
    3  BCHAN      INTEGER         PAR          0  CHAN     REAL                PAR
    2  DL         REAL            PAR          4  ECHAN    INTEGER             PAR
   30  I          INTEGER                      1  LMID     INTEGER             PAR
    6  MASS       INTEGER         PAR          0  MAX      INTEGER              F.P.
    7  MAXE       INTEGER         PAR          5  NCHAN    INTEGER             PAR
   10  OFFSET     REAL            PAR          3  SIGCAL   REAL       ARRAY     F.P.
   27  SIGMAX     REAL

FILE NAMES        MODE
    TAPE6         FMT

STATEMENT LABELS
   13  1                          23  255     FMT

LOOPS  LABEL   INDEX     FROM-TO     LENGTH    PROPERTIES
   11  1       I         10 14        38       INSTACK

COMMON BLOCKS  LENGTH
    PAR          9

STATISTICS
  PROGRAM LENGTH                 318     26
  SCM LABELED COMMON LENGTH      110      9
        61000B SCM USED
```

```
      SUBROUTINE TRAPI
      COMMON/TRIP/WIDTH,HZ,DIA,SA,SB,TRP(191),ITRSIZ,ITRSHF,IFLAG
      DATA PI,CON/3.14159265,100000./
C
C     DEFINITION OF INPUT PARAMETERS
C     SA=WHEEL SLIT WIDTH IN MILLIMETERS
C     SB=DETECTOR SLIT WIDTH IN MILLIMETERS
C     WIDTH= CHANNEL TIME IN MICROSECONDS
C     DIA=DIAMETER FROM CENTER OF WHEEL TO DETECTOR SLIT IN CM.
C     T=ONE HALF THE NUMBER OF CHANNELS PER MILLIMETER TRAVEL OF WHEEL
C     TT=HALF THE NUMBER OF SLITS FOR BASE OF TRAPEZOID
C     TA=HALF THE NUMBER OF SLITS FOR THE TOP OF TRAPEZOID
C     ITT=INTEGRAL VERSION OF TT
C     ITA=INTEGRAL VERSION OF TA
C     ITRSIZ=NUMBER OF CHANNELS AFFECTED BY DIGITAL FILTER
C     ITRSHF        ITRSIZ=2*ITRSHF+1
C
      T=CON/(PI*DIA*HZ*2.*WIDTH)
      TT=T*(SA+SB)
      SA=AMIN1(SA,SB)
      TA=TT-SA*T*2.
      ITT=INT(TT-.5)
      ITA=INT(TA-.5)
C
C     CHECK IF BASE OF TRAPEZOID LESS THAN ONE CHANNEL WIDE
C
      IF(TT.LE..5) GOTO 90
      ITRSIZ=1+2*(ITT+1)
      ITRSHF=(ITT+1
C
C     CHECK IF TOP OF TRAPEZOID MORE THAN ONE CHANNEL WIDE
C
      IF(TA.GE..5) GOTO 40
C
C     TRAPEZOID CORNER OCCURS WITHIN THE FIRST CHANNEL
C
      TRP(10)=(TT-TA*TA-.25)/(TT-TA)
C
C     CHECK IF TRAPEZOID BASE OCCURS WITHIN FIRST CHANNEL
C
      IF(ITT.EQ.0) GOTO 30
C
C     TRAPEZOID EDGE SPREAD OVER ITT CHANNELS
C
      DO 20 I=1,ITT
      TRP(10+I)=(TT-FLOAT(I))/(TT-TA)
   20 TRP(10-I)=TRP(10+I)
C
C     CHANNEL WHERE EDGE HITS BASE
C
   30 TRP(11+ITT)=(TT-.5-FLOAT(ITT))**2/(2.*(TT-TA))
      TRP(9-ITT)=TRP(11+ITT)
      GOTO 75
C
C     CASE WHERE TOP OF TRAPEZOID AT LEAST ONE CHANNEL WIDE.
```

```
      A(1)=1.
C
C     DOES TOP OF TRAPEZOID EXTEND OVER MORE THAN ONE CHANNEL?
C
      IF(ITA.EQ.0.) GOTO 50
C
C     IF SO THAN ALL THESE CHANNELS HAVE UNIT AREA
C
      DO 45 I=1,ITA
      TRP(10+I)=1.
   45 TRP(10-I)=1.
C
C     IS EDGE OF TRAPEZOID CONTAINED WITHIN ONE CHANNEL.
C
   50 IF(ITT.EQ.ITA) GOTO 70
C
C     AREA FOR CORNER OF TRAPEZOID.
C
      TERM=FLOAT(ITA)+1.5-TA
      TRP(11+ITA)=1.-TERM*TERM/(2*(TT-TA))
      TRP(9-ITA)=TRP(11+ITA)
C
C     CHANNELS WITH EDGE OF TRAPEZOID, BUT NO CORNERS
C
C
C     CHECK IF THERE ARE PURE EDGE CHANNELS
C
      IF(2+ITA-ITT.GT.0) GOTO 60
      ILOW=2+ITA
      DO 55 I=ILOW,ITT
      TRP(11+I)=(TT-FLOAT(I))/(TT-TA)
   55 TRP(10-I)=TRP(10+I)
C
C     CHANNEL WHERE EDGE HITS BASE
C
   60 TRP(11+ITT)=(TT-.5-FLOAT(ITT))**2/(2.*(TT-TA))
      TRP(9-ITT)=TRP(11+ITT)
      GOTO 75
C
C     CASE WHERE EDGE CONTAINED IN ONE CHANNEL
C
   70 TRP(11+ITT)=(TA+TT-1)*.5-FLOAT(ITA)
      TRP(9-ITT)=TRP(11+ITT)
      GOTO 75
C
C     CASE WHERE ALL OF TRAPEZOID IN ONE CHANNEL
C
   90 TRP(10)=1.
      ITRSIZ=1
      ITRSHF=0
C
C     NORMALIZE SO TRAPEZOID HAS UNIT AREA
C
   75 SUM=0.
```

```
                    AREA=TA+TT
                    ILOW=10-ITRSHF
                    IHIGH=10+ITRSHF
                    DO 77 I=ILOW,IHIGH
      115           TRPI(I)=TRPI(I)/AREA
               77   SUM=SUM+TRPI(I)
                    WRITE(6,103)
              103   FORMAT(//)
                    WRITE(6,1000)(TRPI(I),I=ILOW,IHIGH)
      120     1000  FORMAT(1H ,*SHUTTER FUNCTION TRAPEZOID*,  2X,19F6.3)
                    WRITE(6,103)
                    RETURN
                    END
```

```
CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM

     120     I     57CD 120  FIELD WIDTH OF A CONVERSION DESCRIPTOR SHOULD BE AS LARGE AS THE MINIMUM SPECIFIED FOR THAT DESCRIPTOR
```

```
          SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
     1  TRAPI

VARIABLES     SN  TYPE          RELOCATION
   207  AREA      REAL                          146  CON       REAL
     2  DIA       REAL            TRIP            1  HZ        REAL            TRIP
   203  I         INTEGER                        32  IFLAG     INTEGER         TRIP
   210  IHIGH     INTEGER                       205  ILOW      INTEGER
   202  ITA       INTEGER                        31  ITRSHF    INTEGER         TRIP
    30  ITRSIZ    INTEGER         TRIP          201  ITT       INTEGER
   145  PI        REAL                            3  SA        REAL            TRIP
     4  SB        REAL            TRIP          206  SUM       REAL
   176  T         REAL                          203  TA        REAL
   204  TERM      REAL                            6  TRP       REAL      ARRAY TRIP
   177  TT        REAL                            7  WIDTH     REAL            TRIP

FILE NAMES      MODE
     TAPE6      FMT

INLINE FUNCTIONS   TYPE   ARGS
     AMINI         REAL      0  INTRIN                 FLOAT     REAL      1  INTRIN
     INT           INTEGER   1  INTRIN

STATEMENT LABELS
     0  20                                  37  30                                 46  40
     0  45                                  55  50                                  0  55
    76  60                                 105  70                                121  75
     0  77                                 115  90                                157  103     FMT
```

STATEMENT LABELS
160 1000 FMT

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
33	20	I	45 47	48	INSTACK
53	45	I	65 67	28	INSTACK
72	55	I	86 88	40	INSTACK
127	77	I	114 116	38	INSTACK

COMMON BLOCKS LENGTH
TRIP 27

STATISTICS
PROGRAM LENGTH 2118 137
SCM LABELED COMMON LENGTH 338 27
61000B SCM USED

CARD NO.

FMTNT PRINT
1. TPSPI

VARIABLES

```
      SUBROUTINE HALF(EXPT,H)
      COMMON/PAR/CHAN,LMID,DL,BCHAN,ECHAN,NCHAN,MASS,MAXE,OFFSET
      DIMENSION EXPT(255)
      REAL MASS,LMID
      INTEGER NCHAN,ECHAN,NCHAN
C
C     CALCULATE CHANNEL NUMBER OF APPROXIMATE HALF HEIGHT
C
C
C     ASSUME DC LEVEL GIVEN BY THE COUNTS IN THE THIRD CHANNEL
C
      DC=EXPT(NCHAN+3)
C
C     MAXE IS THE CHANNEL NUMBER OF THE PEAK OF THE DISTRIBUTION
C
      H=(EXPT(MAXE)+DC)/2.
      DO 10 I=BCHAN,MAXE
C
C     ASSUME FIRST CHANNEL WHOSE SIGNAL IS LARGER THAN THE CALCULATED
C     HALF HEIGHT IS THE CORRECT CHANNEL
C
      IF(EXPT(I).LT.H) GOTO 10
      T1=(EXPT(I)-EXPT(I-1))
      B=EXPT(I)+EXPT(I-1)-T1*FLOAT(2*I-1)
      B=B/2.
      H=(H-B)/T1
      GOTO 20
   10 CONTINUE
   20 RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 HALF

VARIABLES	SN	TYPE		RELOCATION					
35	B	REAL			3	BCHAN	INTEGER	PAR	
0	CHAN	REAL		PAR	32	DC	REAL		
2	DL	REAL		PAR	4	ECHAN	INTEGER	PAR	
0	EXPT	REAL	ARRAY	F.P.	0	H	REAL	F.P.	
33	I	INTEGER			1	LMID	REAL	PAR	
4	MASS	REAL		PAR	7	MAXE	INTEGER	PAR	
5	NCHAN	INTEGER		PAR	10	OFFSET	REAL	PAR	
34	T1	REAL							

INLINE FUNCTIONS	TYPE	ARGS	
FLOAT	REAL	1	INTRIN

```
STATEMENT LABELS
    20  10                          27  20

LOOPS  LABEL   INDEX   FROM-TO   LENGTH   PROPERTIES
   14  10      1       17 28     13B      OPT     EXITS

COMMON BLOCKS   LENGTH
      PAR          9

STATISTICS
  PROGRAM LENGTH                  36B     30
  SCM LABELED COMMON LENGTH       11B      9
        61000B SCM USED
```

```
      SUBROUTINE INDATA(EXPT,BETA,VZRO)
      DIMENSION EXPT(255),TITLE(20)
      COMMON/PAR/CHAN,LMID,DL,BCHAN,ECHAN,NCHAN,MASS,MAXE,OFFSET
      COMMON/TRIP/WIDTH,HZ,DIA,SA,SB,TRP(19),ITRSIZ,ITRSHF,IFLAG
      INTEGER BCHAN,ECHAN,      BC,EC
      REAL MASS,LMID
      READ(5,102) TITLE
  102 FORMAT(20A4)
      READ(5,101)MASS,CHAN,LMID,DL,OFFSET
      IF(MASS .EQ. 0.0) STOP
      READ(5,100) BCHAN,ECHAN
  100 FORMAT(3I5)
      BC=BCHAN
      EC=ECHAN
      NCHAN=ECHAN-BCHAN+1
      READ(5,101)HZ,DIA,SA,SB
      READ(5,101) (EXPT (I), I=BCHAN,ECHAN)
  101 FORMAT(8F10.1)
      WRITE(6,204) TITLE
  204 FORMAT(1H1,20A4)
C
C     OUTPUT DATA
C
      WRITE(6,200) MASS
  200 FORMAT(40  MASS =*,F7.3)
      WRITE(6,201) CHAN,BC,EC,LMID,DL
  201 FORMAT(*   CHANNEL WIDTH =*,F4.1,* MICROSECONDS; BEGINNING CHANNEL
     1 =*,I3,*, ENDING CHANNEL =*,I3,*1 FLIGHT LENGTH =*,F5.2,* CM; ION
     2ER LENGTH =*,F5.2,* CM,*)
      WRITE(6,104)OFFSET
  104 FORMAT(39,*OFFSET= *,F4.1,* CHANNELS*)
      WRITE(6,211)HZ,DIA,SA,SB
  211 FORMAT(*   WHEEL FREQ. =*,F6.0,* HZ; WHEEL DIAMETER =*,F4.1,* CM;
     1SLOT WIDTH = *,F4.2,* MM; DETECTOR APERTURE =*,F4.2,* MM*)
      WRITE(6,103)
  103 FORMAT(//)
      WRITE(6,205)
  205 FORMAT(10X,*I N P U T  D I S T A I B U T I O N*,/)
      WRITE(6,215)(I,EXPT(I),I=BCHAN,ECHAN)
  215 FORMAT(8(3X,I3,1X,F9.1))
      WRITE(6,103)
      WIDTH =CHAN
      IFLAG=0
      CALL TRAP1
C
C     GENERATE ESTIMATE OF BETA AND VZRO
C
      CALL BIG(EXPT,MAXE)
      VZRO=LMID/(FLOAT(MAXE)+OFFSET)/.1/CHAN
      CALL HALF(EXPT,H)
      VTEM=LMID/(H+OFFSET)/.1/CHAN
      BETA=.693/((VTEM-VZRO)**2)
      VZRO=VZRO**2/(VZRO+1./BETA)
      RETURN
      END
```

```
SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    3  INDATA

VARIABLES      SN  TYPE          RELOCATION
  343  BC          INTEGER                      3  BCHAN     INTEGER          PAR
    0  BETA        REAL              F.P.       0  CHAN      REAL             PAR
    2  DIA         REAL              TRIP       2  DL        REAL             PAR
  344  EC          INTEGER                      4  ECHAN     INTEGER          PAR
    0  EXPT        REAL        ARRAY  F.P.    346  H         REAL
    1  HZ          REAL              TRIP     345  I         INTEGER
   32  IFLAG       INTEGER           TRIP      31  IFRSHF    INTEGER          TRIP
   30  IIRSIZ      INTEGER           TRIP       1  LNIG      REAL             PAR
    6  MASS        REAL              PAR        7  MAXE      INTEGER          PAR
    5  NCHAN       INTEGER           PAR       10  OFFSET    REAL             PAR
    3  SA          REAL              TRIP       4  SR        REAL             TRIP
  350  TITLE       REAL        ARRAY            5  TRP       REAL       ARRAY TRIP
  347  VTEM        REAL                         5  VIRD      REAL             F.P.
    0  WIDTH       REAL              TRIP

FILE NAMES      MODE
     TAPE5      FMT                 TAPE6      FMT

EXTERNALS          TYPE   ARGS
     BIG            2                        HALF        2
     TRAP1          0

INLINE FUNCTIONS   TYPE   ARGS
     FLOAT         REAL    1   INTRIN

STATEMENT LABELS
  198  100   FMT                 175  101   FMT                 135  102   FMT
  306  103   FMT                 251  104   FMT                 211  203   FMT
  274  201   FMT                 203  204   FMT                 313  205   FMT
  269  211   FMT                 330  215   FMT

LOOPS  LABEL   INDEX   FROM-TO   LENGTH   PROPERTIES
   56          I        39 39      78       EXT REFS

COMMON BLOCKS   LENGTH
     PAR           9
     TRIP         27

STATISTICS
  PROGRAM LENGTH                 376B     254
  SCM LABELED COMMON LENGTH      44B       36
        61000B SCM USED
```

```
      SUBROUTINE LPPLT (X1,Y1,NPT1,X2,Y2,NPT2,ND)
      DIMENSION IPA(120),IX1(300),IY1(300),IX2(300),IY2(300)
      DIMENSION X1(300),X2(300),Y1(300),Y2(300)
      DATA L1,L2,L3,L4,L5,L0,LA / 1H1,1H2,1H3,1H4,1H5,1H0,1H* /
      DATA LR,LI,LM,LP / 1H ,1HI,1H-,1H+ /
      DATA DX,DY / 0.025,0.125 /
      WRITE(6,2001)
 2001 FORMAT (1H1)
      IF (ND .EQ. 9) GOTO 20
      IF (ND .EQ. 1) LND=L1
      IF (ND .EQ. 2) LND=L2
      IF (ND .EQ. 3) LND=L3
      IF (ND .EQ. 4) LND=L4
      GOTO 21
   20 CONTINUE
      LND=L5
      WRITE (6,2003)
 2003 FORMAT (1H /)
   21 CONTINUE
      DO 1 I=1,NPT1
      IF (X1(I) .LT. DX) X1(I)=DX
      IF (Y1(I) .LT. -3.+DY) Y1(I)=-3.+DY
      IX1(I)=INT((X1(I)+DX)/(2.*DX))
      IY1(I)=INT((Y1(I)+3.+DY)/(2.*DY))+4
    1 CONTINUE
      DO 10 I=1,NPT2
      IF (X2(I) .LT. DX) X2(I)=DX
      IF (Y2(I) .LT. -3.+DY) Y2(I)=-3.+DY
      IX2(I)=INT((X2(I)+DX)/(2.*DX))
      IY2(I)=INT((Y2(I)+3.+DY)/(2.*DY))+4
   10 CONTINUE
      DO 2 I=1,18
      IPA(I)=LB
    2 CONTINUE
      DO 7 N=1,97
      N2=60-N+1
      DO 3 I=19,120
      IPA(I)=LB
    3 CONTINUE
      IPA(20)=LI
      IF (FLOAT(N2)/8.-N2/8) .GT. 1.E-6) GOTO 5
      IPA(19)=LM
      IPA(20)=LM
      IF (N2 .NE. 16) GOTO 5
      DO 4 I=21,120
      IPA(I)=LM
      IF ((FLOAT(I)/10.-I/10) .LE. 1.E-6) IPA(I)=LP
    4 CONTINUE
    5 CONTINUE
      DO 6 I=1,NPT1
      IF (IY1(I) .NE. N2) GOTO 6
      IPA(20+IX1(I))=LO
    6 CONTINUE
      DO 12 I=1,NPT2
      IF (IY2(I) .NE. N2) GOTO 12
```

```
                    IND=20+IX2(I)
                    IF (IPA(IND) .EQ. LB) IPA(IND)=LNO
                    IF (IPA(IND) .EQ. LD) IPA(IND)=LA
                    IF (IPA(IND) .EQ. LM) IPA(IND)=LNO
      60        12  CONTINUE
                    WRITE (6,2000) (IPA(I),I=1,120)
                7   CONTINUE
                2000 FORMAT (120A1)
                    RETURN
      65            END
```

```
SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
    9  LPPLT

VARIABLES     SN  TYPE          RELOCATION
  221  DX         REAL                          222  DY        REAL
  252  I          INTEGER                       255  IND       INTEGER
  256  IPA        INTEGER   ARRAY               446  IX1       INTEGER   ARRAY
 1576  IX2        INTEGER   ARRAY              1122  IY1       INTEGER   ARRAY
 2252  IY2        INTEGER   ARRAY               214  LA        INTEGER
  215  LB         INTEGER                       216  LI        INTEGER
  217  LM         INTEGER                       251  LNO       INTEGER
  213  LO         INTEGER                       220  LP        INTEGER
  212  LS         INTEGER                       206  L1        INTEGER
  207  L2         INTEGER                       210  L3        INTEGER
  211  L4         INTEGER                       257  N         INTEGER
    0  ND         INTEGER          F.P.           0  NPT1      INTEGER          F.P.
    0  NPT2       INTEGER          F.P.         254  NZ        INTEGER
    0  X1         REAL      ARRAY  F.P.           3  X2        REAL      ARRAY  F.P.
    0  Y1         REAL      ARRAY  F.P.           3  Y2        REAL      ARRAY  F.P.

FILE NAMES        MODE
     TAPE6        FMT

INLINE FUNCTIONS  TYPE   ARGS
     FLOAT        REAL     1  INTRIN                 INT       INTEGER   1  INTRIN

STATEMENT LABELS
    0  1                                  0  2                                 0  3
    0  4                                131  5                               157  6
    0  7                                  0  10                              177  12
   32  20                                35  21                              241  2000   FMT
  226  2001   FMT                       233  2003   FMT

LOOPS  LABEL   INDEX     FROM-TO    LENGTH   PROPERTIES
   45  1       I         20 25       168      OPT
   79  10      I         26 31       168      OPT
  113  2       I         32 34        28     INSTACK
  117  7       N         35 62       668              EXT REFS  NOT INNER
```

LOOPS	LABEL	INDEX	FROM-TO	LENGTH	PROPERTIES
123	3	1	37 39	2B	INSTACK
142	4	1	45 48	7B	INSTACK
155	6	1	50 53	3B	INSTACK
165	12	1	54 60	13B	OPT

STATISTICS

PROGRAM LENGTH 2731B 1497

61000B SCM USED

```
      SUBROUTINE VELOBETA,VZRO,SIGCAL,SIG1,SIG2)
C
C     CALCULATES THE TOF SPECTRA AVERAGED OVER THE IONIZER LENGTH AND
C     SHUTTER FUNCTION
C
      COMMON/PAR/CHAN,LMID,DL,BCHAN,ECHAN,NCHAN,MASS,MAXE,OFFSET
      COMMON/TRIP/WIDTH,HZ,DIA,SA,SB,TRP(19),ITRSZ,ITRSHF,IFLAG
      DIMENSION SIGTEM(255),SIGCAL(255)
      DIMENSION SIGCA1(255),SIGCA2(255),SIG1(255),SIG2(255)
      REAL MASS,LMID,L
      INTEGER BCHAN,ECHAN
      N=3
C
C     ZERO ARRAYS
C     SIGCA1, SIGCA2 CONTAIN THE ANALYTICAL DERIVATIVES OF THE DISTRIBU-
C     TION WITH RESPECT TO VZRO AND BETA RESPECTIVELY. THE SHUTTER
C     CONVOLUTED RESULTS ARE RETURNED IN SIG1, SIG2.
C
      DO 5 I=1,255
      SIGCAL(I)=0.
      SIGTEM(I)=0.
      SIGCA1(I)=0.
      SIGCA2(I)=0.
      SIG1(I)=0.
      SIG2(I)=0.
    5 CONTINUE
      ILOW=BCHAN+ITRSHF
      IHIGH=ECHAN-ITRSHF
C
C     NINT IS THE GRID SIZE FOR THE SIMPSON'S RULE INTEGRATION
C     OVER THE CHANNEL WIDTH. IF THE BEAM WIDTH IS VERY NARROW, THEN
C     SET IFLAG=1 AND THIS INTEGRATION IS PERFORMED, ELSE USE IFLAG=0
C     AND THE ROUTINE IS ROUGHLY 6 TIMES FASTER.
C     NINT SHOULD PROBABLY BE ODD.
C     SEE 'INTRODUCTION TO NUMERICAL ANALYSIS BY HILDEBRAND,SECOND
C     ED., PG. 93.
C     THE CURRENT VALUE OF NINT IS CHOOSEN SUCH THAT IF A FINER GRID
C     IS NEEDED, THEN THE SIMULATION OF THE EXPERIMENT BY THIS PROGRAM
C     IS PROBABLY MORE IN ERROR.
C
      NINT=11
C
C     DIVIDE IONIZER INTO NION INTERVALS
C     NOTE THAT NION SHOULD BE ODD
C
      NION=11
C
C     THESE CONSTANTS ARE USED IN THE INTERVALS FOR THE IONIZER INTEGRA-
C     TION AND THE CHANNEL WIDTH INTGRATION.
C
      S2=FLOAT(NINT-1)
      N12=NINT-2
      NMID=(NION+1)/2
      S=FLOAT(NION-1)
      C1=CHAN*.1
```

```
      C2=CHAN*.1*(-.5)
C
C     THE 40 DO LOOP TREATS EACH POINT IN THE IONIZER EQUALLY, AND
C     MODELS THE EXPERIMENT BY NION INDEPENDENT AND SLIGHTLY DISPLACED
C     IONIZERS.
C
      DO 40 I=1,NION
      L=LMID+FLOAT(I-NMID)*DL/S
      DO 35 J=BCHAN,ECHAN
      IF(IFLAG.EQ.0) GOTO 30
C
C     THE DO LOOP PERFORMS THE SIMPSON'S RULE INTEGRATION
C
C     T1 IS THE LEFT EDGE OF THE CHANNEL.
      T1=C1*(FLOAT(J-1)+OFFSET)
      V1=L/T1
      X1=V1**N*EXP(-BETA*((V1-VZRO)**2))/T1
      W1=0.
      W2=0.
      W=0.
C
C     DT IS THE STEP LENGTH IN TIME SPACE FOR THE INTEGRATION
C     OVER THE CHANNEL WIDTH
C
      DT=C1/S2
      DO 25 K=1,N12,2
      T2=T1+DT
      T3=T2+DT
      V2=L/T2
      V3=L/T3
      X2=V2**N*EXP(-BETA*((V2-VZRO)**2))/T2
      X3=V3**N*EXP(-BETA*((V3-VZRO)**2))/T3
      W=W+X1+4.*X2+X3
      W1=W1+X1*2.*BETA*(V1-VZRO)*X2*8.*BETA*(V2-VZRO)*X3*2.*BETA*(V3-VZR
     10)
      W2=W2-X1*(V1-VZRO)**2-X3*(V3-VZRO)**2-4.*X2*(VZ-VZRO)**2
      X1=X3
      T1=T3
   25 CONTINUE
      SIGTEM(J)=SIGTEM(J)+W*DT/3.
C      DERIVATIVE OF INTENSITY WITH RESPECT TO VZRO.
      SIGCA1(J)=SIGCA1(J)+W1*DT/3.
C      DERIVATIVE OF INTENSITY WITH RESPECT TO BETA.
      SIGCA2(J)=SIGCA2(J)+W2*DT/3.
      GOTO 35
C
C     APPROXIMATE THE AREA OF THE VELOCITY DISTRIBUTION IN THIS CHANNEL
C     BY ITS VALUE AT THE MIDPOINT.
C
   30 T=C1*(FLOAT(J)+OFFSET)+C2
C
C      CALCULATE THE VELOCITY OF THE PARTICLE DETECTED IN CHANNEL J
C     IF IT WAS IONIZED AT THIS DISTANCE L FROM THE COLLISION ZONE
C
      V=L/T
```

```
C
C     USING THE GIVEN VELOCITY DISTRIBUTION, CALCULATE THE RELATIVE
C     AMOUNT EXPECTED TO HAVE THIS VELOCITY
C
      C=V**N*EXP(-BETA*(V-VZRO)**2) /T
C      DERIVATIVE OF INTENSITY WITH RESPECT TO VZRO.
      SIGCA1(J)=SIGCA1(J)+2.*BETA*(V-VZRO)*C
C      DERIVATIVE OF INTENSITY WITH RESPECT TO BETA.
      SIGCA2(J)=SIGCA2(J)+C*(-(V-VZRO)**2)
      SIGTEM(J)=SIGTEM(J)+C
   35 CONTINUE
   40 CONTINUE
      DO 60 I=ILOW,IHIGH
C
C     CONVOLUTE NOW OVER THE SHUTTER FUNCTION USING THE TRAP ARRAY AS A
C     DIGITAL FILTER
C
      ITEMP=10-I
      JLOW=I-ITRSHF
      JHIGH=I+ITRSHF
      DO 55 J=JLOW,JHIGH
      K=J+ITEMP
      SIG1(I)=SIG1(I)+TRP(K)*SIGCA1(J)
      SIG2(I)=SIG2(I)+TRP(K)*SIGCA2(J)
      SIGCAL(I)=SIGCAL(I)+TRP(K)*SIGTEM(J)
   55 CONTINUE
   60 CONTINUE
      RETURN
      END
```

SYMBOLIC REFERENCE MAP (R=1)

ENTRY POINTS
3 VELO

VARIABLES		SN	TYPE	RELOCATION					
3	BCHAN		INTEGER	PAR	0	BETA	REAL		F.P.
307	C		REAL		3	CHAN	REAL		PAR
264	C1		REAL		265	C2	REAL		
2	DIA		REAL	TRIP	2	DL	REAL		PAR
275	DT		REAL		4	ECHAN	INTEGER		PAR
1	HI		REAL	TRIP	253	I	INTEGER		
32	IFLAG		INTEGER	TRIP	255	IHIGH	INTEGER		
254	ILOW		INTEGER		310	ITEMP	INTEGER		
31	ITRSHF		INTEGER	TRIP	30	ITRSIZ	INTEGER		TRIP
266	J		INTEGER		312	JHIGH	INTEGER		
311	JLOW		INTEGER		276	K	INTEGER		
251	L		REAL		1	LMID	REAL		PAR
6	MASS		REAL	PAR	7	MAXE	INTEGER		PAR
252	N		INTEGER		5	NCHAN	INTEGER		PAR
256	NINT		INTEGER		257	NION	INTEGER		
262	NMID		INTEGER		261	NIZ	INTEGER		

```
VARIABLES     SN  TYPE          RELOCATION
     10  OFFSET   REAL          PAR          263  S        REAL
      3  SA       REAL          TRIP           4  SB       REAL          TRIP
      0  SIGCAL   REAL    ARRAY   F.P.       712  SIGCA1   REAL    ARRAY
   1311  SIGCA2   REAL    ARRAY              313  SIGTEM   REAL    ARRAY
      0  SIGL     REAL    ARRAY   F.P.         0  SIG2     REAL    ARRAY   F.P.
    260  SZ       REAL                       305  T        REAL
      5  TMP      REAL    ARRAY   TRIP       267  T1       REAL
    277  T2       REAL                       303  T3       REAL
    306  V        REAL                         3  VZRO     REAL            F.P.
    270  V1       REAL                       301  V2       REAL
    302  V3       REAL                       274  W        REAL
      0  WIDTH    REAL            TRIP       272  W1       REAL
    271  W2       REAL                       271  X1       REAL
    303  X2       REAL                       304  X3       REAL

EXTERNALS          TYPE   ARGS
     EXP           REAL     1  LIBRARY

INLINE FUNCTIONS   TYPE   ARGS
     FLOAT         REAL     1  INTRIN

STATEMENT LABELS
      0  5                          0  25                    156  30
    204  35                         0  40                      3  55
      0  60

LOOPS  LABEL   INDEX    FROM-TO    LENGTH   PROPERTIES
     13  5      I        19 26        4B     INSTACK
     39  40     I        62 122      154B     EXT REFS  NOT INNER
     43  35     J        64 121      144B     EXT REFS  NOT INNER
     72  25     K        81 94       53B      EXT REFS
    220  60     I       123 136      16B      NOT INNER
    223  55     J       131 135       7B    INSTACK

COMMON BLOCKS  LENGTH
     PAR          9
     TRIP        27

STATISTICS
  PROGRAM LENGTH              17276    983
  SCM LABELED COMMON LENGTH     44B     36
      610008 SCM USED
```

```
FL REQUIRED TO LOAD    33600
FL REQUIRED TO RUN     21600
INITIAL TRANSFER TO KELVIN    -    1267


BLOCK ASSIGNMENTS.

BLOCK          ADDRESS   LENGTH   FILE

 /PAR/           100       11
 /TRIP/          111       33
KELVIN           144     5303    LGO
FIT             5447       57    LGO
BIG             5526       31    LGO
TRAP1           5557      211    LGO
HALF            5770       36    LGO
INDATA          6026      376    LGO
LPPLT           6424     2731    LGO
VELD            11355    1727    LGO
 /STP.END/      13304       1
 /FCL.C./       13305      26
 /QLIMLMT/      13333       1
 /OJOBSFL/      13334       2
 /QASAFLG/      13336       1
 /.QCOMP./      13337       1
 /QB.IO./       13340     171
FTN4LIB         13531       1    FTN4LIB
CIO=            13532      13    FTN4LIB
COMIO=          13545      60    FTN4LIB
EMOJ=           13625       2    FTN4LIB
EXP.            13627      73    FTN4LIB
EXP.MSG         13722      16    FTN4LIB
FECMSK=         13740      51    FTN4LIB
FLTIN=          14001     156    FTN4LIB
FLTOUT=         14157     314    FTN4LIB
FMTAP=          14473     406    FTN4LIB
FORSYS=         15101     662    FTN4LIB
 /OOVERL7/      15763       1
FORUTL=         15764      16    FTN4LIB
F.OPEN          16002     120    FTN4LIB
F.READF         16122     170    FTN4LIB
F.WRITF         16312     122    FTN4LIB
GETFIT=         16434      43    FTN4LIB
GETFP.          16477      60    FTN4LIB
INCOM=          16537     262    FTN4LIB
INPE=           17041     236    FTN4LIB
KODE=           17275     516    FTN4LIB
KRAKER=         20033     435    FTN4LIB
OUTCOM=         20470     242    FTN4LIB
OUTC=           20732     155    FTN4LIB
QZNTAV=         21107      31    FTN4LIB
RDC=            21140      23    FTN4LIB
SPA=            21163      11    FTN4LIB
```

LOAD MAP.
BLOCK ASSIGNMENTS.

BLOCK	ADDRESS	LENGTH	FILE
SQRT.	21174	32	FTN4LIB
SYSAID*	21226	1	FTN4LIB
SYS*	21227	34	FTN4LIB
SYS*AID	21263	7	FTN4LIB
SYS*1ST	21272	62	FTN4LIB
UZERO..	21354	2	FTN4LIB
WTH*	21356	30	FTN4LIB
WTO*	21406	17	FTN4LIB
WTW*	21425	66	FTN4LIB
XTOI.	21513	63	FTN4LIB

AR F3F BENZENE DIMER CALIBRATION

MASS = 40.000
CHANNEL WIDTH = 2.0 MICROSECONDS; BEGINNING CHANNEL = 81, ENDING CHANNEL =255; FLIGHT LENGTH =16.46 CMS; IONIZER LENGTH = 1.00 CM.
OFFSET= -8.4 CHANNELS
WHEEL FREQ. =400. HZ; WHEEL DIAMETER =17.3 CM; SLOT WIDTH = .76 MM; DETECTOR APERTURE = .13 MM

INPUT DISTRIBUTION

81	120.0	82	122.0	83	142.0	84	144.0	85	119.0	86	128.0	87	139.0	88	120.0
89	126.0	90	139.0	91	136.0	92	132.0	93	131.0	94	150.0	95	140.0	96	127.0
97	135.0	98	137.0	99	138.0	100	147.0	101	124.0	102	142.0	103	140.0	104	127.0
105	133.0	106	143.0	107	121.0	108	144.0	109	142.0	110	138.0	111	134.0	112	134.0
113	131.0	114	162.0	115	155.0	116	144.0	117	157.0	118	169.0	119	166.0	120	164.0
121	200.0	122	179.0	123	211.0	124	225.0	125	258.0	126	289.0	127	268.0	128	340.0
129	348.0	130	364.0	131	454.0	132	528.0	133	615.0	134	698.0	135	817.0	136	914.0
137	1061.0	138	1290.0	139	1462.0	140	1671.0	141	1983.0	142	2171.0	143	2481.0	144	2652.0
145	2913.0	146	3182.0	147	3539.0	148	3837.0	149	4129.0	150	4265.0	151	4507.0	152	4590.0
153	4759.0	154	4751.0	155	4895.0	156	4780.0	157	4812.0	158	4694.0	159	4583.0	160	4344.0
161	4230.0	162	3901.0	163	3776.0	164	3507.0	165	3362.0	166	3024.0	167	2746.0	168	2546.0
169	2394.0	170	2122.0	171	1894.0	172	1775.0	173	1575.0	174	1444.0	175	1266.0	176	1219.0
177	1048.0	178	956.0	179	873.0	180	800.0	181	743.0	182	643.0	183	662.0	184	589.0
185	492.0	186	502.0	187	502.0	188	418.0	189	391.0	190	364.0	191	389.0	192	333.0
193	327.0	194	271.0	195	276.0	196	281.0	197	262.0	198	237.0	199	251.0	200	234.0
201	220.0	202	209.0	203	233.0	204	233.0	205	241.0	206	216.0	207	194.0	208	221.0
209	202.0	210	223.0	211	192.0	212	204.0	213	194.0	214	193.0	215	196.0	216	189.0
217	185.0	218	181.0	219	161.0	220	221.0	221	159.0	222	203.0	223	188.0	224	149.0
225	173.0	226	174.0	227	159.0	228	149.0	229	185.0	230	166.0	231	175.0	232	173.0
233	157.0	234	167.0	235	177.0	236	165.0	237	152.0	238	170.0	239	160.0	240	146.0
241	157.0	242	147.0	243	135.0	244	167.0	245	187.0	246	174.0	247	138.0	248	160.0
249	136.0	250	126.0	251	148.0	252	161.0	253	119.0	254	143.0	255	155.0		

SHUTTER FUNCTION TRAPEZOID .214,.571,.214

INTERMEDIATE VALUES

STANDARD DEVIATION= .558E+01 DBETA= -.2113E+00 DVZRO= -.6386E-01
STANDARD DEVIATION= .564E+01 DBETA= .2192E-01 DVZRO= -.1980E-03
STANDARD DEVIATION= .563E+01 DBETA= .1229E-01 DVZRO= .1790E-03

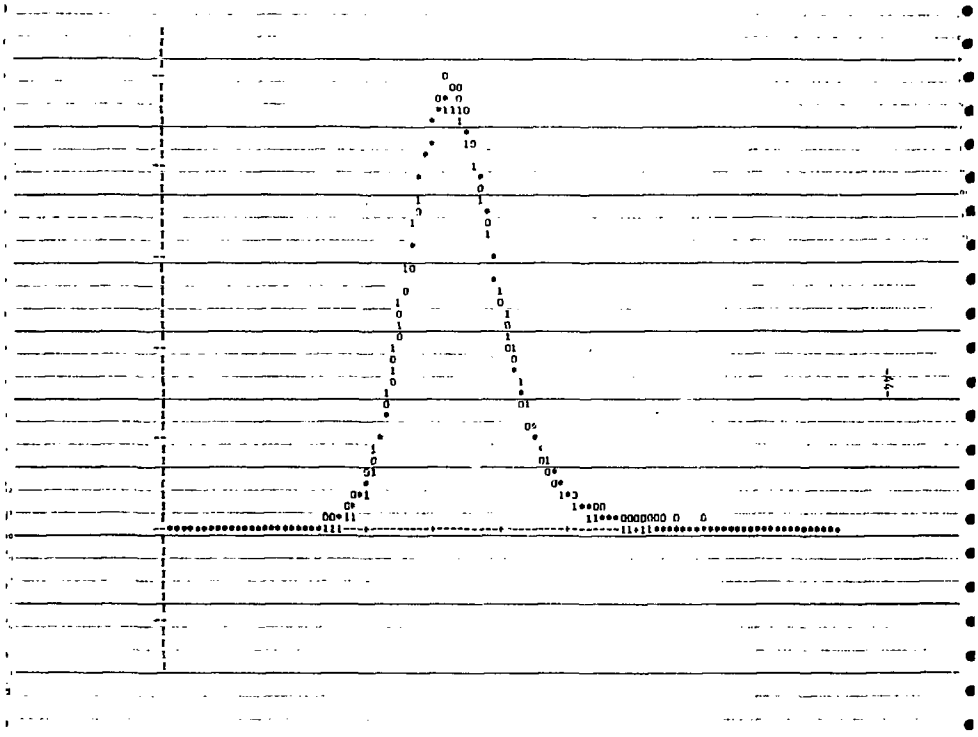
FINAL PARAMETER VALUES

BETA= .2751E+01 VZRO= .3517E+01 SPEED RATIO= .9152E+01 ALPHA= .6029E+00 ITERATIONS= 3 AVERAGE DEVIATION= 2.3
ESTIMATED ERROR IN LOCATION OF MINIMUM ON SURFACE IN BETA AND VZRO= .6804E-02 .1419E-02

CALCULATED DISTRIBUTION

82	160.9	83	150.9	84	160.9	85	160.9	86	163.9	87	160.9	88	153.9	89	160.9
90	160.9	91	160.9	92	160.9	93	160.9	94	163.9	95	163.9	96	160.9	97	160.9
98	160.9	99	160.9	100	160.9	101	160.9	102	160.9	103	160.9	104	160.9	105	160.9

106	160.9	107	160.9	108	160.9	109	160.9	110	160.9	111	160.9	112	160.9	113	160.9
114	160.9	115	161.0	116	161.0	117	161.2	118	161.4	119	161.9	120	167.7	121	164.1
122	164.4	123	170.1	124	175.7	125	184.2	126	196.7	127	214.4	128	239.1	129	272.6
130	317.0	131	374.6	132	447.7	133	538.6	134	649.1	135	781.1	136	935.5	137	1112.9
138	1312.7	139	1533.9	140	1774.1	141	2030.4	142	2296.9	143	2574.8	144	2853.1	145	3128.2
146	3394.5	147	3646.3	148	3878.3	149	4085.9	150	4264.9	151	4411.8	152	4524.4	153	4601.2
154	4641.7	155	4646.2	156	4616.0	157	4553.3	158	4459.9	159	4339.7	160	4195.8	161	4037.0
162	3851.9	163	3659.3	164	3457.9	165	3250.9	166	3041.6	167	2832.9	168	2627.1	169	2426.4
170	2232.6	171	2047.2	172	1871.1	173	1705.3	174	1553.1	175	1435.8	176	1277.6	177	1150.1
178	1038.3	179	938.6	180	844.7	181	761.9	182	687.6	183	621.2	184	562.2	185	508.8
186	463.7	187	423.0	188	387.3	189	356.3	190	328.7	191	305.0	192	284.4	193	266.5
194	251.1	195	237.8	196	226.4	197	216.6	198	211.2	199	201.0	200	194.9	201	189.6
202	185.2	203	181.4	204	178.2	205	175.4	206	173.1	207	171.2	208	169.5	209	168.2
210	167.0	211	166.0	212	165.2	213	164.5	214	163.9	215	163.4	216	163.0	217	162.6
218	162.4	219	162.1	220	161.9	221	161.7	222	161.6	223	161.5	224	161.4	225	161.3
226	161.2	227	161.2	228	161.1	229	161.1	230	161.1	231	161.0	232	161.0	233	161.0
234	161.0	235	161.0	236	160.9	237	160.9	238	160.9	239	160.9	240	160.9	241	160.9
242	160.9	243	160.9	244	160.9	245	160.9	246	160.9	247	160.9	248	160.9	249	160.9
250	160.9	251	160.9	252	160.9	253	160.9	254	160.9						



CR TOF CALIBRATION BENZENE DIMER

MASS = 84.000
CHANNEL WIDTH = 3.2 MICROSECONDS; BEGINNING CHANNEL = 81, ENDING CHANNEL =2241 FLIGHT LENGTH =18.46 CM; IONIZER LENGTH = 1.00 CM.
OFFSET= -8.3 CHANNELS
WHEEL FREQ. =250. HZ; WHEEL DIAMETER =17.3 CM; SLOT WIDTH = .76 MM; DETECTOR APERTURE = .13 MM

INPUT DISTRIBUTION

81	182.0	82	203.0	83	177.0	84	185.0	85	198.0	86	163.0	87	194.0	88	187.0
89	180.0	90	192.0	91	199.0	92	181.0	93	172.0	94	180.0	95	181.0	96	199.0
97	179.0	98	198.0	99	183.0	100	155.0	101	191.0	102	183.0	103	186.0	104	211.0
105	213.0	106	202.0	107	202.0	108	193.0	109	226.0	110	236.0	111	270.0	112	236.0
113	255.0	114	267.0	115	266.0	116	286.0	117	284.0	118	355.0	119	422.0	120	418.0
121	572.0	122	667.0	123	786.0	124	931.0	125	1194.0	126	1346.0	127	1468.0	128	1773.0
129	2212.0	130	2628.0	131	3064.0	132	3570.0	133	4174.0	134	4807.0	135	5687.0	136	6300.0
137	7224.0	138	8055.0	139	8938.0	140	9823.0	141	10611.0	142	11458.0	143	12322.0	144	13102.0
145	13584.0	146	14106.0	147	14622.0	148	14864.0	149	15116.0	150	15140.0	151	15056.0	152	14772.0
153	14448.0	154	14133.0	155	13776.0	156	12895.0	157	12510.0	158	11704.0	159	10855.0	160	10211.0
161	9439.0	162	8741.0	163	8145.0	164	7628.0	165	6843.0	166	6114.0	167	5586.0	168	5241.0
169	4507.0	170	4121.0	171	3660.0	172	3267.0	173	2916.0	174	2629.0	175	2353.0	176	2123.0
177	1885.0	178	1678.0	179	1506.0	180	1355.0	181	1232.0	182	1097.0	183	1009.0	184	864.0
185	838.0	186	785.0	187	685.0	188	673.0	189	633.0	190	546.0	191	488.0	192	465.0
193	458.0	194	446.0	195	426.0	196	404.0	197	378.0	198	361.0	199	370.0	200	344.0
201	317.0	202	309.0	203	328.0	204	316.0	205	327.0	206	276.0	207	328.0	208	277.0
209	291.0	210	272.0	211	304.0	212	301.0	213	306.0	214	307.0	215	278.0	216	298.0
217	261.0	218	295.0	219	267.0	220	299.0	221	262.0	222	257.0	223	284.0	224	252.0

SHUTTER FUNCTION TRAPEZOID .232.535.232

INTERMEDIATE VALUES

STANDARD DEVIATION=	.159E+02	DBETA=	-.1666E+00	DVZRO=	-.4633E-01
STANDARD DEVIATION=	.132E+02	DBETA=	.1602E+00	DVZRO=	.1765E-02
STANDARD DEVIATION=	.125E+02	DBETA=	.8631E-01	DVZRO=	.3333E-03
STANDARD DEVIATION=	.123E+02	DBETA=	.4598E-01	DVZRO=	.1631E-03
STANDARD DEVIATION=	.122E+02	DBETA=	.2395E-01	DVZRO=	.8320E-04

FINAL PARAMETER VALUES

BETA= .5136E+01 VZRO= .3801E+01 SPEED RATIO= .8527E+01 ALPHA= .4413E+00 ITERATIONS= 5 AVERAGE DEVIATION= 3.4
ESTIMATED ERROR IN LOCATION OF MINIMUM ON SURFACE IN BETA AND VZRO= .6323E-07 .545ME-01

CALCULATED DISTRIBUTION

82	236.4	83	236.4	84	236.4	85	236.4	86	236.4	87	236.4	88	236.4	89	236.4
90	236.4	91	236.4	92	236.4	93	236.4	94	236.4	95	236.4	96	236.4	97	236.4
98	236.4	99	236.4	100	236.4	101	236.4	102	236.4	103	236.4	104	236.4	105	236.4
106	236.4	107	236.4	108	236.5	109	236.5	110	236.7	111	237.0	112	237.6	113	238.8
114	240.8	115	244.3	116	250.2	117	259.7	118	274.7	119	297.0	120	331.5	121	380.5

122	449.6	123	544.4	124	671.5	125	838.3	126	1051.3	127	1318.7	128	1647.0	129	7042.1
130	2538.1	131	3047.3	132	3659.5	133	4341.9	134	5088.6	135	5891.0	136	6737.8	137	7615.3
138	8506.9	139	9396.4	140	10265.8	141	11097.1	142	11873.2	143	12576.5	144	13198.9	145	13723.1
146	14142.1	147	14450.1	148	14644.1	149	14723.9	150	14692.1	151	14553.8	152	14316.2	153	13987.0
154	13579.1	155	13100.7	156	12564.4	157	11981.5	158	11361.5	159	10721.3	160	10065.1	161	9406.2
162	8746.9	163	8100.6	164	7471.4	165	6864.4	166	6281.7	167	5732.4	168	5217.7	169	4725.6
170	4272.9	171	3853.6	172	3467.7	173	3114.1	174	2791.3	175	2499.3	176	2234.3	177	1996.9
178	1783.5	179	1592.8	180	1422.9	181	1272.1	182	1134.6	183	1020.8	184	917.1	185	826.1
186	746.3	187	676.7	188	615.9	189	563.1	190	517.2	191	477.5	192	443.1	193	413.4
194	387.8	195	365.8	196	346.9	197	330.6	198	316.7	199	304.7	200	294.5	201	285.8
202	278.4	203	272.0	204	266.6	205	262.0	206	258.1	207	254.8	208	252.0	209	249.5
210	247.6	211	245.8	212	244.4	213	243.1	214	242.1	215	241.2	216	240.5	217	239.8
218	239.3	219	238.8	220	238.5	221	238.1	222	237.9	223	237.6				

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XE TOF CALIBRATION BENZENE DIMER

MASS =131.000
CHANNEL WIDTH = 3.0 MICROSECONDS; BEGINNING CHANNEL =121; ENDING CHANNEL =255; FLIGHT LENGTH =16.4 CM; IONIZER LENGTH = 1.00 CM.
OFFSET= -11. CHANNELS
WHEEL FREQ. =250. HZ; WHEEL DIAMETER =11.3 CM; SLOT WIDTH = .76 MM; DETECTION APERTURE = .13 MM

INPUT DISTRIBUTION

121	119.0	122	101.0	123	134.0	124	125.0	125	125.0	126	121.0	127	126.0	128	131.0
129	137.0	130	113.0	131	123.0	132	107.0	133	112.0	134	128.0	135	141.0	136	133.0
137	147.0	138	171.0	139	166.0	140	153.0	141	172.0	142	152.0	143	171.0	144	197.0
145	201.0	146	225.0	147	218.0	148	238.0	149	272.0	150	326.0	151	379.0	152	406.0
153	478.0	154	533.0	155	611.0	156	721.0	157	816.0	158	944.0	159	1158.0	160	1249.0
161	1404.0	162	1625.0	163	1907.0	164	2228.0	165	2459.0	166	2845.0	167	3231.0	168	3563.0
169	3914.0	170	4418.0	171	4804.0	172	5230.0	173	5681.0	174	6252.0	175	6677.0	176	7219.0
177	7590.0	178	8057.0	179	8385.0	180	8734.0	181	9311.0	182	9367.0	183	9751.0	184	9724.0
185	10031.0	186	10047.0	187	10101.0	188	10347.0	189	10636.0	190	9693.0	191	9737.0	192	9316.0
193	9160.0	194	8835.0	195	8616.0	196	8149.0	197	7732.0	198	7410.0	199	6496.0	200	6658.0
201	6366.0	202	5758.0	203	5474.0	204	5053.0	205	4677.0	206	4411.0	207	4335.0	208	3773.0
209	3657.0	210	3133.0	211	2898.0	212	2727.0	213	2657.0	214	2158.0	215	2064.0	216	1861.0
217	1770.0	218	1557.0	219	1436.0	220	1309.0	221	1166.0	222	1111.0	223	1038.0	224	894.0
225	835.0	226	761.0	227	720.0	228	617.0	229	596.0	230	601.0	231	558.0	232	484.0
233	478.0	234	410.0	235	398.0	236	354.0	237	345.0	238	345.0	239	312.0	240	302.0
241	250.0	242	283.0	243	248.0	244	227.0	245	232.0	246	234.0	247	241.0	248	199.0
249	215.0	250	253.0	251	189.0	252	215.0	253	214.0	254	201.0	255	195.0		

SHUTTER FUNCTION TRAPEZOID .23E.535.23E

INTERMEDIATE VALUES

STANDARD DEVIATION=	.120E+02	DBETA=	-.3945E+00	DVZ03=	-.4264E-01
STANDARD DEVIATION=	.953E+01	DBETA=	.2512E+00	DVZ02=	.1343E-02
STANDARD DEVIATION=	.877E+01	DBETA=	.1455E+00	DVZ03=	.4059E-03
STANDARD DEVIATION=	.853E+01	DBETA=	.8279E-01	DVZ02=	.2121E-03
STANDARD DEVIATION=	.8[illegible]E+01	DBETA=	.4544E-01	DVZ03=	.1130E-03
STANDARD DEVIATION=	.845E+01	DBETA=	.2478E-01	DVZ02=	.6039E-04

FINAL PARAMETER VALUES

BETA= .8111E+01 VZ02= .3058E+01 SPEED RATIO= .8710E+01 ALPHA= .4511E+00 ITERATIONS= 6 AVERAGE DEVIATION= 2.9
ESTIMATED ERROR IN LOCATION OF MINIUM ON SURFACE IN BETA AND VZ2 is .1394E-01 .4787E-03

CALCULATED DISTRIBUTION

122	158.0	123	158.0	124	158.0	125	158.0	126	158.0	127	158.0	128	158.0	129	158.0
130	158.0	131	158.0	132	158.0	133	158.0	134	158.0	135	158.0	136	158.0	137	158.1
138	158.2	139	158.4	140	158.8	141	159.3	142	160.2	143	161.6	144	163.8	145	167.1
146	171.9	147	179.0	148	189.0	149	203.0	150	222.1	151	247.9	152	281.9	153	306.3
154	383.2	155	454.9	156	544.0	157	651.1	158	784.9	159	941.9	160	1126.2	161	1337.9

162	1584.6	163	1861.0	164	2169.5	165	2509.7	166	2843.3	167	3279.1	168	3705.3	169	4149.1
170	4612.0	171	5087.0	172	5568.4	173	6051.2	174	6526.1	175	6989.8	176	7436.9	177	7855.6
178	8246.1	179	8631.4	180	8917.0	181	9189.2	182	9415.1	183	9593.5	184	9720.2	185	9797.8
186	9825.7	187	9804.9	188	9737.4	189	9625.6	190	9472.3	191	9281.0	192	9055.4	193	8799.3
194	8516.9	195	8212.3	196	7889.5	197	7552.6	198	7235.3	199	6851.3	200	6596.1	201	6136.7
202	5781.9	203	5432.2	204	5087.9	205	4756.8	206	4431.6	207	4121.4	208	3827.3	209	3544.1
210	3275.2	211	3021.1	212	2781.8	213	2557.4	214	2347.5	215	2152.0	216	1970.4	217	1802.2
218	1646.9	219	1501.9	220	1372.6	221	1252.2	222	1147.3	223	1042.0	224	950.8	225	868.0
226	793.0	227	725.1	228	663.8	229	608.7	230	559.3	231	514.4	232	474.5	233	439.7
234	426.7	235	378.1	236	352.7	237	330.3	238	332.8	239	2[illegible]1.9	240	276.0	241	261.9
242	249.5	243	238.4	244	228.7	245	220.1	246	212.5	247	205.8	248	199.9	249	194.7
250	190.2	251	186.1	252	182.6	253	179.5	254	176.9						

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BENZENE MONOMER 3.21 MVOLT NOZZLE,400 TORR TOTAL/HE,23 CENT. BATH

MASS = 78.000
CHANNEL WIDTH = 2.0 MICROSECONDS; BEGINNING CHANNEL = 49, ENDING CHANNEL =160; FLIGHT LENGTH =16.46 CM; IONIZER LENGTH = 1.03 CM.
OFFSET= -11. CHANNELS
WHEEL FREQ. =401. HZ; WHEEL DIAMETER =17.3 CM; SLOT WIDTH = .76 MM; DETECTOR APERTURE = .13 MM

INPUT DISTRIBUTION

49	78.0	50	73.0	51	75.0	52	70.0	53	76.0	54	57.0	55	66.0	56	68.0
57	87.0	58	74.0	59	79.0	60	77.0	61	75.0	62	79.0	63	91.0	64	83.0
65	69.0	66	67.0	67	76.0	68	69.0	69	76.0	70	59.0	71	73.0	72	63.0
73	75.0	74	77.0	75	66.0	76	78.0	77	81.0	78	81.0	79	92.0	80	100.0
81	158.0	82	193.0	83	317.0	84	457.0	85	713.0	86	1112.0	87	1833.0	88	2557.0
89	3665.0	90	4967.0	91	6611.0	92	8097.0	93	10000.0	94	11831.0	95	13085.0	96	14740.0
97	15231.0	98	15667.0	99	15353.0	100	15081.0	101	14185.0	102	13187.0	103	11411.0	104	10414.0
105	9063.0	106	7611.0	107	6589.0	108	5495.0	109	4488.0	110	3827.0	111	3170.0	112	2498.0
113	2187.0	114	1774.0	115	1475.0	116	1277.0	117	1059.0	118	861.0	119	689.0	120	640.0
121	587.0	122	475.0	123	472.0	124	397.0	125	317.0	126	289.0	127	284.0	128	243.0
129	243.0	130	221.0	131	199.0	132	191.0	133	167.0	134	182.0	135	168.0	136	151.0
137	139.0	138	137.0	139	43.0	140	22.0	141	18.0	142	138.0	143	176.0	144	125.0
145	105.0	146	99.0	147	91.0	148	98.0	149	136.0	150	99.0	151	117.0	152	99.0
153	96.0	154	84.0	155	89.0	156	76.0	157	101.0	158	77.0	159	99.0	160	97.0

SHUTTER FUNCTION TRAPEZOID .214,.572,.214

INTERMEDIATE VALUES

STANDARD DEVIATION= .280E+02 DBETA= -.1736E+00 DVZRO= -.3996E-01
STANDARD DEVIATION= .249E+02 DBETA= -.2752E-01 DVZRO= -.9749E-02
STANDARD DEVIATION= .247E+02 DBETA= -.1173E-01 DVZRO= -.1637E-02
STANDARD DEVIATION= .247E+02 DBETA= -.5391E-02 DVZRO= -.6681E-03

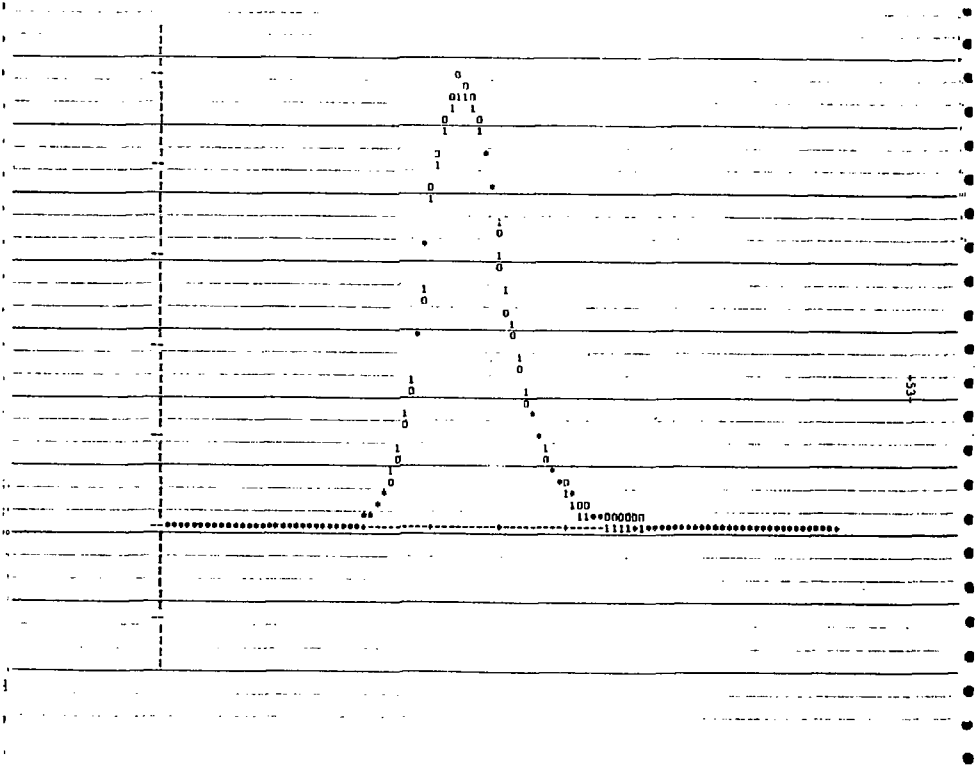
FINAL PARAMETER VALUES

BETA= .1145E+01 VZRO= .9230E+01 SPEED RATIO= .9876E+01 ALPHA= .9346E+00 ITERATIONS= 4 AVERAGE DEVIATION= 4.9
ESTIMATED ERROR IN LOCATION OF MINIMUM ON SURFACE IN BETA AND VZRO= .1792E-02 .1504E-02

CALCULATED DISTRIBUTION

50	84.3	51	84.3	52	84.3	53	84.3	54	84.3	55	84.3	56	84.3	57	84.3
58	84.3	59	84.3	60	84.3	61	84.3	62	84.3	63	84.3	64	84.3	65	84.3
66	84.3	67	84.3	68	84.3	69	84.3	70	84.3	71	84.3	72	84.3	73	84.3
74	84.3	75	84.6	76	84.6	77	85.3	78	87.5	79	93.1	80	106.3	81	139.2
82	193.1	83	300.7	84	486.8	85	787.3	86	1242.1	87	1889.2	88	2757.8	89	3856.2
90	5172.8	91	6665.1	92	8264.3	93	9883.9	94	11414.3	95	12764.8	96	13645.6	97	14492.0
98	14968.0	99	14957.7	100	14213.5	101	13950.4	102	13019.0	103	11948.0	104	10746.6	105	9499.2
106	8261.0	107	7076.0	108	5976.1	109	4981.6	110	4103.1	111	3342.6	112	2696.5	113	2156.5
114	1712.0	115	1351.1	116	1061.7	117	832.4	118	652.7	119	513.1	120	405.7	121	323.8
122	261.7	123	215.1	124	180.2	125	154.4	126	135.3	127	121.2	128	111.0	129	103.5

130	98.1	131	94.2	132	91.3	133	89.3	134	87.3	135	86.8	136	86.1	137	85.6
138	85.2	139	84.9	140	84.7	141	84.6	142	84.5	143	84.4	144	84.4	145	84.4
146	84.3	147	84.3	148	84.3	149	84.3	150	84.3	151	84.3	152	84.3	153	84.3
154	84.3	155	84.3	156	84.3	157	84.3	158	84.3	159	84.3				



BENZENE DIMER, 3,21 AT PRIZE=.00 TORR TOTAL/HE,23 BATH

MASS =156.000
CHANNEL WIDTH = 2.0 MICROSECONDS; BEGINNING CHANNEL = 73, ENDING CHANNEL =160; FLIGHT LENGTH =16.60 CM; IONIZER LENGTH = 1.00 CM,
OFFSET= -16. CHANNELS
WHEEL FREQ. =401. HZ; WHEEL DIAMETER =17.3 CM; SLOT WIDTH = .76 MM; DETECTOR APERTURE = .13 MM

INPUT DISTRIBUTION

73	16587.0	74	16976.0	75	16630.0	76	16864.0	77	16914.0	78	16997.0	79	16831.0	80	16723.0
81	16772.0	82	16762.0	83	16989.0	84	16884.0	85	17047.0	86	16731.0	87	16738.0	88	16928.0
89	16904.0	90	16929.0	91	16758.0	92	16937.0	93	17003.0	94	16926.0	95	17086.0	96	17351.0
97	17605.0	98	18060.0	99	18476.0	100	19351.0	101	20346.0	102	21415.0	103	22369.0	104	22875.0
105	23726.0	106	24662.0	107	24725.0	108	24815.0	109	24865.0	110	24020.0	111	23382.0	112	22627.0
113	21604.0	114	20922.0	115	20278.0	116	19784.0	117	19104.0	118	19618.0	119	18308.0	120	17984.0
121	17925.0	122	17360.0	123	17526.0	124	17596.0	125	17143.0	126	17013.0	127	17117.0	128	17784.0
129	17130.0	130	17043.0	131	17078.0	132	16999.0	133	16915.0	134	16677.0	135	16462.0	136	17152.0
137	16755.0	138	16947.0	139	16952.0	140	17003.0	141	16899.0	142	16983.0	143	16959.0	144	16833.0
145	16789.0	146	16655.0	147	17038.0	148	16878.0	149	16831.0	150	16658.0	151	16878.0	152	16744.0
153	17208.0	154	16804.0	155	16523.0	156	17103.0	157	16925.0	158	16862.0	159	16779.0	160	16769.0
161	16902.0	162	16940.0	163	16698.0	164	16781.0	165	16806.0	166	16695.0	167	16670.0	168	16957.0

SHUTTER FUNCTION TRAPEZOID .214.572.214

INTERMEDIATE VALUES

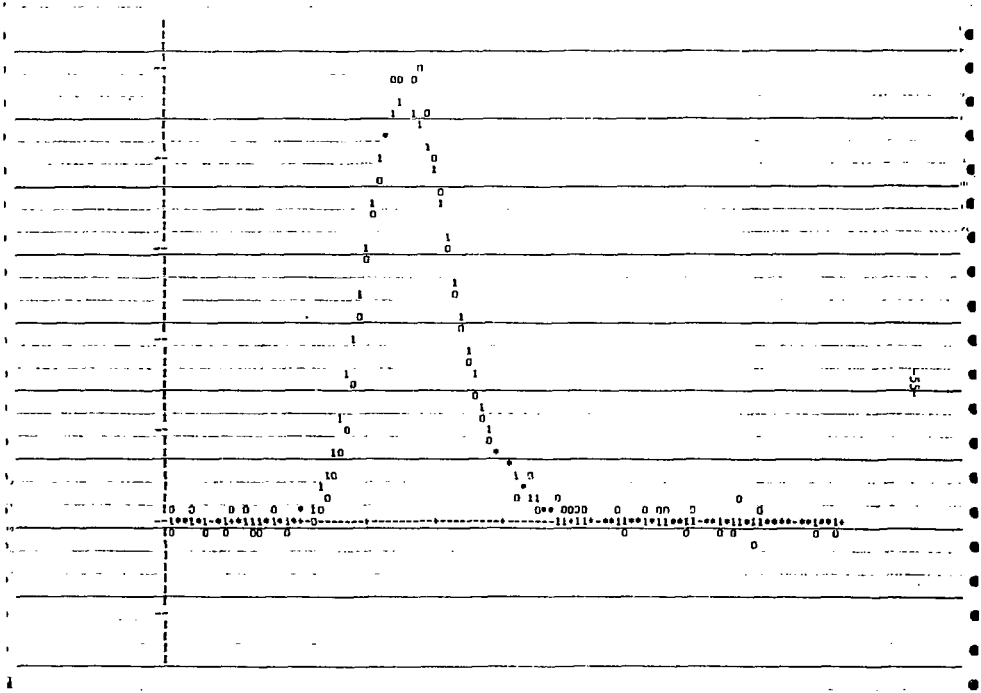
STANDARD DEVIATION= .410E+01 DBETA= .2942E+00 DVZRO= .1556E+00

FINAL PARAMETER VALUES

BETA= .1424E+01 VZRO= .8924E+01 SPEED RATIO= .1065E+02 ALPHA= .9381E+00 ITERATIONS= 1 AVERAGE DEVIATION= 2.0
ESTIMATED ERROR IN LOCATION OF MINIUM ON SURFACE IN BETA AND VZRO= .1384E-01 .6190E-02

CALCULATED DISTRIBUTION

74	16802.7	75	16802.7	76	16802.7	77	16802.7	78	16832.7	79	16832.7	80	16832.7	81	16802.7
82	16802.7	83	16802.7	84	16802.8	85	16802.9	86	16803.2	87	16804.2	88	16806.9	89	16819.4
90	16827.6	91	16856.2	92	16909.7	93	17002.9	94	17154.1	95	17384.1	96	17712.6	97	18154.4
98	18715.1	99	19387.1	100	20148.0	101	20951.3	102	21774.5	103	22547.0	104	23214.0	105	23734.4
106	24075.6	107	24220.9	108	24170.1	109	23938.0	110	23551.4	111	23044.6	112	22455.6	113	21821.4
114	21175.4	115	20560.5	116	19995.1	117	19415.0	118	18937.3	119	18522.4	120	18173.2	121	17877.1
122	17637.0	123	17443.6	124	17290.2	125	17169.9	126	17076.9	127	17005.8	128	16952.0	129	16911.6
130	16881.6	131	16859.5	132	16843.4	133	16831.7	134	16823.2	135	16817.2	136	16812.9	137	16809.9
138	16807.7	139	16806.2	140	16805.1	141	16804.4	142	16803.8	143	16803.5	144	16803.2	145	16803.1
146	16803.0	147	16802.9	148	16802.9	149	16802.8	150	16802.8	151	16802.8	152	16802.7	153	16802.7
154	16802.7	155	16802.7	156	16802.7	157	16802.7	158	16802.7	159	16802.7	160	16802.7	161	16802.7
162	16802.7	163	16802.7	164	16802.7	165	16802.7	166	16802.7	167	16802.7				



COOLED AR 14 TEST CHAMBER

MASS = 40.000
CHANNEL WIDTH =10.3 MICROSECONDS; BEGINNING CHANNEL =101; ENDING CHANNEL =2501; FLIGHT LENGTH =68.77 CM; IONIZER LENGTH = .53 CM.
OFFSET= -2.6 CHANNELS
WHEEL FREQ. = 72. HZ; WHEEL DIAMETER =11.8 CM; SLOT WIDTH = .78 MM; DETECTOR APERTURE = .91 MM

INPUT DISTRIBUTION

101	47939.0	102	48365.0	103	48208.0	104	47793.0	105	48189.0	106	47536.0	107	47917.0	108	48219.0
109	47842.0	110	48457.0	111	48138.0	112	48313.0	113	47947.0	114	48313.0	115	48391.0	116	47878.0
117	47886.0	118	47842.0	119	47987.0	120	47771.0	121	48135.0	122	48497.0	123	48191.0	124	48227.0
125	47889.0	126	48064.0	127	48287.0	128	48519.0	129	47901.0	130	48062.0	131	48417.0	132	48072.0
133	47928.0	134	48651.0	135	48347.0	136	48590.0	137	48811.0	138	48731.0	139	48696.0	140	49204.0
141	49396.0	142	50011.0	143	50102.0	144	50905.0	145	51152.0	146	51684.0	147	52139.0	148	51902.0
149	53798.0	150	54116.0	151	54697.0	152	55823.0	153	55745.0	154	58241.0	155	58422.0	156	59973.0
157	60675.0	158	62008.0	159	62721.0	160	64551.0	161	65076.0	162	66138.0	163	67020.0	164	67653.0
165	68031.0	166	68894.0	167	69485.0	168	68775.0	169	68535.0	170	69123.0	171	68497.0	172	67686.0
173	67511.0	174	66624.0	175	65890.0	176	65014.0	177	64337.0	178	63267.0	179	62592.0	180	62319.0
181	60167.0	182	59464.0	183	58785.0	184	58008.0	185	57362.0	186	56558.0	187	55855.0	188	54977.0
189	54577.0	190	53935.0	191	53359.0	192	52755.0	193	52656.0	194	51672.0	195	51749.0	196	51183.0
197	50646.0	198	50556.0	199	50027.0	200	50312.0	201	49546.0	202	49519.0	203	49658.0	204	49667.0
205	48781.0	206	49087.0	207	48705.0	208	49022.0	209	48736.0	210	48541.0	211	48654.0	212	48469.0
213	48729.0	214	48674.0	215	48580.0	216	48824.0	217	48446.0	218	48602.0	219	48369.0	220	48737.0
221	48292.0	222	47828.0	223	48525.0	224	48323.0	225	48031.0	226	48202.0	227	48234.0	228	49524.0
229	48197.0	230	47813.0	231	48366.0	232	47986.0	233	47935.0	234	47902.0	235	47845.0	236	48349.0
237	47853.0	238	48025.0	239	47776.0	240	48113.0	241	48743.0	242	48050.0	243	48327.0	244	48187.0
245	48112.0	246	48227.0	247	48287.0	248	47895.0	249	48142.0	250	47711.0				

SHUTTER FUNCTION TRAPEZOID .022.117.217.286.217.117.022

INTERMEDIATE VALUES

STANDARD DEVIATION= .471E+01 DBETA= .3910E+00 DV2R0= -.8420E-02
STANDARD DEVIATION= .293E+01 DBETA= .3083E+00 DV2R0= .3469E-02

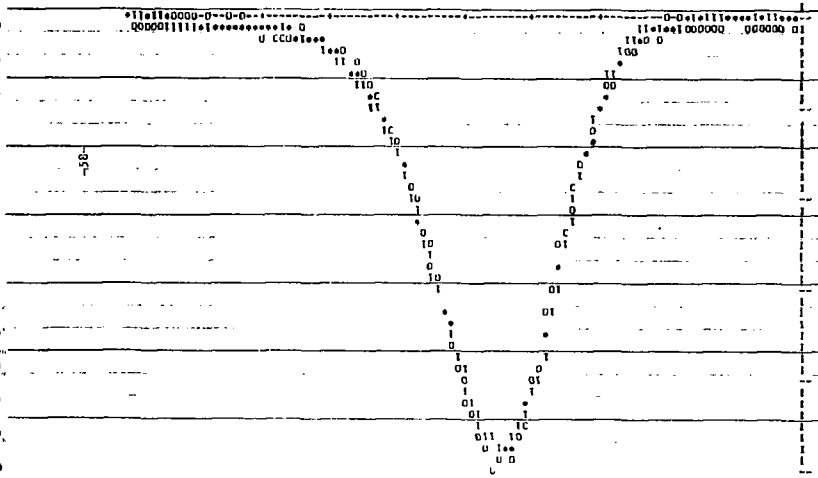
FINAL PARAMETER VALUES

BETA= .4952E+01 VZR0= .4076E+01 SPEED RATIO= .8697E+01 ALPHA= .4687E+00 ITERATIONS= 2 AVERAGE DEVIATION= 1.7
ESTIMATED ERROR IN LOCATION OF MINIUM ON SURFACE IN BETA AND VZR0= .1824E-01 .1353E-02

CALCULATED DISTRIBUTION

101	48049.6	102	48049.6	103	48049.6	104	48049.6	105	48049.6	106	48049.6	107	48049.6	108	48049.6
109	48049.6	110	48049.6	111	48049.6	112	48049.6	113	48049.6	114	48049.6	115	48049.6	116	48049.6
117	48049.6	118	48049.6	119	48049.6	120	48049.6	121	48049.7	122	48049.8	123	48050.3	124	48052.1
125	48057.1	126	48062.1	127	48069.8	128	48081.5	129	48099.3	130	48124.5	131	48160.8	132	48211.4
133	48280.7	134	48373.5	135	48495.6	136	48653.5	137	48853.8	138	49103.7	139	49410.3	140	49780.3
141	50219.8	142	50733.7	143	51325.6	144	51997.1	145	52743.9	146	53575.2	147	54473.9	148	55436.5
149	56452.4	150	57510.0	151	58594.9	152	59691.6	153	60731.5	154	61853.3	155	62884.0	156	63808.9

160	64762.6	161	65580.7	162	66301.2	163	66913.9	164	67411.0	165	67787.4	166	68040.1	167	68168.8		
168	68175.7	169	68064.6	170	67841.8	171	67514.6	172	67092.1	173	66584.2	174	66001.2	175	65354.4		
176	64654.6	177	63912.9	178	63139.9	179	62345.6	180	61539.5	181	60730.3	182	59925.7	183	59132.6		
184	58357.0	185	57604.0	186	56877.7	187	56181.7	188	55519.3	189	54889.4	190	54296.3	191	53739.4		
192	53219.0	193	52734.6	194	52285.5	195	51870.8	196	51489.1	197	51138.9	198	50818.8	199	50527.0		
200	50261.9	201	50021.3	202	49803.9	203	49607.9	204	49431.6	205	49273.3	206	49131.6	207	49004.9		
208	48891.9	209	48791.3	210	48701.9	211	48622.6	212	48552.3	213	48490.2	214	48435.3	215	48387.0		
216	48344.4	217	48306.9	218	48274.0	219	48245.2	220	48219.9	221	48197.8	222	48178.4	223	48161.5		
224	48146.8	225	48133.9	226	48122.7	227	48113.0	228	48104.5	229	48097.2	230	48090.8	231	48085.2		
232	48080.4	233	48076.2	234	48072.6	235	48069.5	236	48066.7	237	48064.5	238	48062.4	239	48061.6		
240	48059.1	241	48057.8	242	48056.6	243	48055.7	244	48054.8	245	48054.1	246	48053.5	247	48052.9		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HE 660 PSI SHORT FLIGHT PATH

MASS = 4.000
CHANNEL WIDTH = 2.0 MICROSECONDS) BEGINNING CHANNEL =101, ENDING CHANNEL =2341 FLIGHT LENGTH =29.80 CMS IONIZER LENGTH = 1.00 CM.
OFFSET= -3.0 CHANNELS
WHEEL FREQ. =350. HZ) WHEEL DIAMETER =17.3 CM) SLOT WIDTH = .86 MM) DETECTOR APERTURE = .13 MM

INPUT DISTRIBUTION

101	1063.0	102	1120.0	103	1075.0	104	1088.0	105	1105.0	106	1033.0	107	1057.0	108	1049.0
109	1044.0	110	1038.0	111	1067.0	112	1085.0	113	1331.0	114	1055.0	115	1308.0	116	1089.0
117	1108.0	118	1091.0	119	1069.0	120	1055.0	121	1129.0	122	1074.0	123	1029.0	124	1064.0
125	1134.0	126	1149.0	127	1066.0	128	1134.0	129	1047.0	130	1128.0	131	1075.0	132	1064.0
133	1191.0	134	1121.0	135	1072.0	136	1137.0	137	1183.0	138	1196.0	139	1238.0	140	1296.0
141	1336.0	142	1441.0	143	1391.0	144	1424.0	145	1452.0	146	1433.0	147	1460.0	148	1532.0
149	1501.0	150	1443.0	151	1498.0	152	1653.0	153	1769.0	154	2083.0	155	2923.0	156	5349.0
157	11524.0	158	23211.0	159	37482.0	160	44077.0	161	38751.0	162	25649.0	163	14207.0	164	7875.0
165	4450.0	166	2787.0	167	2084.0	168	1654.0	169	1576.0	170	1411.0	171	1370.0	172	1316.0
173	1356.0	174	1292.0	175	1369.0	176	1347.0	177	1314.0	178	1354.0	179	1311.0	180	1256.0
181	1328.0	182	1350.0	183	1233.0	184	1274.0	185	1259.0	186	1192.0	187	1211.0	188	1132.0
189	1096.0	190	1137.0	191	1225.0	192	1172.0	193	1093.0	194	1397.0	195	1166.0	196	1124.0
197	1021.0	198	1086.0	199	1073.0	200	1115.0	201	1143.0	202	1022.0	203	1054.0	204	1090.0

SHUTTER FUNCTION TRAPEZOID .280,.440,.280

INTERMEDIATE VALUES

STANDARD DEVIATION=	.185E+03	DBETA=	.8467E+01	DVZRO=	.1986E-01
STANDARD DEVIATION=	.161E+03	DBETA=	.7542E+01	DVZRO=	-.1718E-02
STANDARD DEVIATION=	.145E+03	DBETA=	.7115E+01	DVZRO=	.6669E-03
STANDARD DEVIATION=	.135E+03	DBETA=	.6564E+01	DVZRO=	.3225E-03
STANDARD DEVIATION=	.128E+03	DBETA=	.6301E+01	DVZRO=	.2762E-03
STANDARD DEVIATION=	.123E+03	DBETA=	.5459E+01	DVZRO=	.2207E-03
STANDARD DEVIATION=	.123E+03	DBETA=	.4952E+01	DVZRO=	.1811E-03
STANDARD DEVIATION=	.117E+03	DBETA=	.4488E+01	DVZRO=	.1504E-03
STANDARD DEVIATION=	.115E+03	DBETA=	.4067E+01	DVZRO=	.1262E-03
STANDARD DEVIATION=	.114E+03	DBETA=	.3686E+01	DVZRO=	.1370E-03

FINAL PARAMETER VALUES

BETA= .1001E+03 VZRO= .9508E+01 SPEED RATIO= .9514E+02 ALPHA= .9996E-01 ITERATIONS= 10 AVERAGE DEVIATION= 10.5

C A U T I O N----- THE FULL NUMBER OF ITERATIONS HAS OCCURED WITHOUT CONVERGENCE

ESTIMATED ERROR IN LOCATION OF MINIUM ON SURFACE IN BETA AND VZRO= .9844E-01 .2936E-03

CALCULATED DISTRIBUTION

102	1194.6	103	1194.6	104	1194.6	105	1194.6	106	1194.6	107	1194.6	108	1194.6	109	1194.6
110	1194.6	111	1194.6	112	1194.6	113	1194.6	114	1194.6	115	1194.6	116	1194.6	117	1194.6
118	1194.6	119	1194.6	120	1194.6	121	1194.6	122	1194.6	123	1194.6	124	1194.6	125	1194.6

126	1194.6	127	1194.6	128	1194.6	129	1194.6	130	1194.6	131	1194.6	132	1194.6	133	1194.6
134	1194.6	135	1194.6	136	1194.6	137	1194.6	138	1194.6	139	1194.6	140	1194.6	141	1194.6
142	1194.6	143	1194.6	144	1194.6	145	1194.6	146	1194.6	147	1194.6	148	1194.6	149	1194.6
150	1194.6	151	1194.6	152	1195.1	153	1239.6	154	1409.0	155	2745.7	156	7058.9	157	14321.7
158	26789.3	159	31437.7	160	33887.4	161	32689.0	162	27626.6	163	19839.7	164	9845.3	165	4396.2
166	1806.2	167	1271.8	168	1200.3	169	1194.8	170	1194.6	171	1194.6	172	1194.6	173	1194.6
174	1194.6	175	1194.6	176	1194.6	177	1194.6	178	1194.6	179	1194.6	180	1194.6	181	1194.6
182	1194.6	183	1194.6	184	1194.6	185	1194.6	186	1194.6	187	1194.6	188	1194.6	189	1194.6
190	1194.6	191	1194.6	192	1194.6	193	1194.6	194	1194.6	195	1194.6	196	1194.6	197	1194.6
198	1194.6	199	1194.6	200	1194.6	201	1194.6	202	1194.6	203	1194.6				

XE0002.TOF

MASS = 44.000
CHANNEL WIDTH = 6.0 MICROSECONDS; BEGINNING CHANNEL =121, ENDING CHANNEL =216; FLIGHT LENGTH =29.40 CM; IONIZER LENGTH = 1.00 CM.
OFFSET= -3.0 CHANNELS
WHEEL FREQ. =150. HZ; WHEEL DIAMETER =17.3 CM; SLOT WIDTH = .86 MM; DETECTOR APERTURE = .13 MM

INPUT DISTRIBUTION

121	1665.0	122	1668.0	123	1629.0	124	1582.0	125	1575.0	126	1533.0	127	1616.0	128	1625.0
129	1521.0	130	1602.0	131	1607.0	132	1607.0	133	1617.0	134	1618.0	13	1616.0	136	1649.0
137	1751.0	138	1735.0	139	1847.0	140	1800.0	141	1323.0	142	2067.0	14	2105.0	144	2158.0
145	2478.0	146	2737.0	147	3099.0	148	3459.0	149	4007.0	150	4527.0	1	5254.0	152	6013.0
153	7189.0	154	8246.0	155	9404.0	156	10810.0	157	12317.0	158	13722.0		15308.0	160	16888.0
161	18238.0	162	19232.0	163	20259.0	164	20985.0	165	21005.0	166	21312.0		21099.0	169	21598.0
169	19922.0	170	18875.0	171	17648.0	172	16322.0	173	15173.0	174	13511.0		12322.0	176	11030.0
177	9936.0	178	8762.0	179	7675.0	180	6846.0	181	6137.0	182	5369.0	183	5016.0	184	4393.0
185	3784.0	186	3577.0	187	3215.0	188	3022.0	189	2799.0	190	2525.0	191	2332.0	192	2332.0
193	2126.0	194	2098.0	195	2026.0	196	1993.0	197	2014.0	198	1813.0	199	1851.0	200	1845.0
201	1742.0	202	1850.0	203	1723.0	204	1722.0	205	1659.0	206	1737.0	207	1612.0	208	1659.0
209	1675.0	210	1665.0	211	1644.0	212	1732.0	213	1579.0	214	1623.0	215	1657.0	216	1618.0

SHUTTER FUNCTION TRAPEZOID .217,.565,.217

INTERMEDIATE VALUES

STANDARD DEVIATION=	.101E+02	DBETA=	.3315E+00	DVZRO=	-.6750E-02
STANDARD DEVIATION=	.427E+01	DBETA=	.3406E+00	DVZRO=	.2134E-03
STANDARD DEVIATION=	.903E+01	DBETA=	.1922E+00	DVZRO=	.9844E-04
STANDARD DEVIATION=	.898E+01	DBETA=	.1065E+00	DVZRO=	.5328E-04
STANDARD DEVIATION=	.894E+01	DBETA=	.5841E-01	DVZRO=	.2881E-04

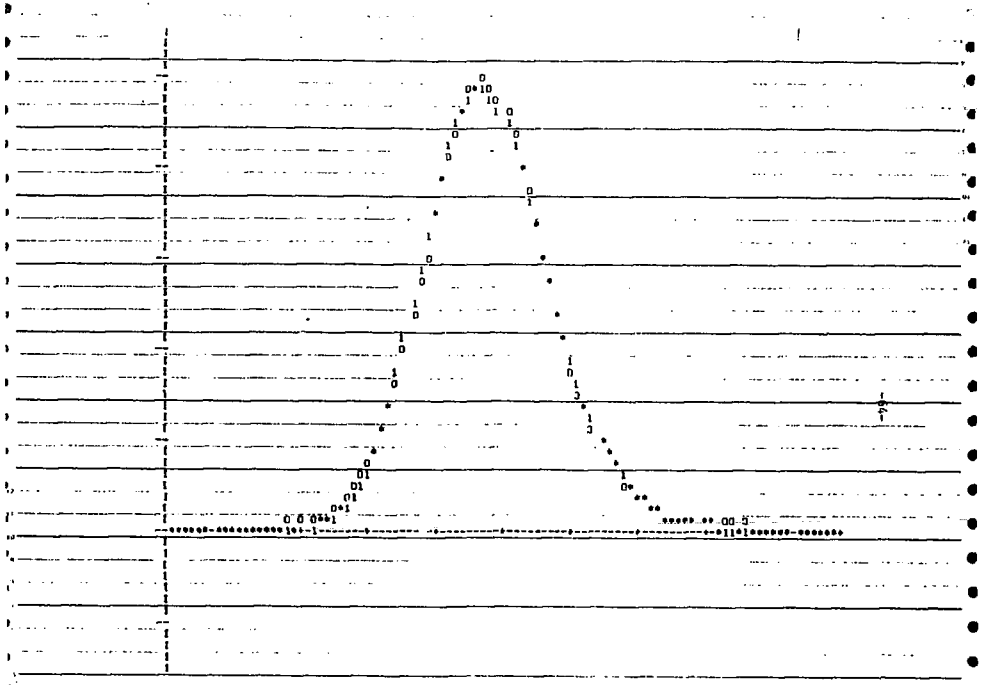
FINAL PARAMETER VALUES

BETA= .2016E+02 VZRO= .3035E+01 SPEED RATIO= .1363E+02 ALPHA= .2227E+00 ITERATIONS= 7 AVERAGE DEVIATION= 2.9
ESTIMATED ERROR IN LOCATION OF MINIUM ON SURFACE IN BETA AND VZRO= .2662E-01 .3101E-03

CALCULATED DISTRIBUTION

122	1705.8	123	1705.8	124	1705.8	125	1705.8	126	1705.8	127	1705.8	128	1705.8	129	1705.8
130	1705.8	131	1705.8	132	1705.9	133	1706.1	134	1716.4	135	1737.2	136	1734.7	137	1711.3
138	1717.3	139	1727.4	140	1744.8	141	1773.8	142	1820.6	143	1893.5	144	2001.1	145	2153.1
146	2389.2	147	2699.1	148	3111.5	149	3644.5	150	4313.9	151	5131.4	152	6122.3	153	7223.9
154	8443.8	155	9860.4	156	11321.6	157	12827.4	158	14330.7	159	15781.0	160	17124.9	161	18319.7
162	19316.4	163	20082.4	164	20593.6	165	20837.1	166	20812.1	167	20578.6	168	20306.7	169	19974.4
170	18365.6	171	17317.5	172	16168.9	173	14957.4	174	13718.5	175	12483.3	176	11270.2	177	10129.7
178	9049.2	179	8050.2	180	7143.0	181	6321.7	182	5575.3	183	4957.0	184	4434.7	185	3929.4
186	3525.2	187	3184.5	188	2899.9	189	2664.0	190	2470.1	191	2312.0	192	2183.9	193	2080.9
194	1998.5	195	1933.1	196	1881.4	197	1840.9	198	1807.3	199	1784.7	200	1765.7	201	1751.1
202	1739.9	203	1731.4	204	1725.0	205	1720.1	206	1716.4	207	1713.7	208	1711.6	209	1710.1

210 1708.9 211 1708.1 212 1707.5 213 1707.0 214 1706.7 215 1706.4



KR0002.TOF

MASS = 42.000
CHANNEL WIDTH = 5.0 MICROSECONDS; BEGINNING CH= 113; ENDING CHANNEL =224; FLIGHT LENGTH =20.90 CM; IONIZER LENGTH = 1.03 CM.
OFFSET= -3.6 CHANNELS
WHEEL FREQ. =200. HZ; WHEEL DIAMETER =17.3 CM; SLIT WIDTH = .86 MM; DETECTOR APERTURE = .13 MM

I N P U T D I S T R I B U T I O N

113	380.0	114	352.0	115	354.0	116	337.0	117	343.0	118	361.0	119	387.0	120	353.0
121	389.0	122	381.0	123	411.0	124	395.0	125	426.0	126	426.0	127	449.0	128	472.0
129	490.0	130	532.0	131	601.0	132	611.0	133	732.0	134	843.0	135	1330.0	136	1139.0
137	1413.0	138	1653.0	139	2166.0	140	2610.0	141	3378.0	142	4112.0	143	4971.0	144	6281.0
145	7761.0	146	9599.0	147	11604.0	148	13956.0	149	16343.0	150	19233.0	151	22221.0	152	25528.0
153	28074.0	154	31026.0	155	33815.0	156	36156.0	157	38066.0	158	39256.0	159	39768.0	160	39614.0
161	39148.0	162	37867.0	163	35859.0	164	33542.0	165	31423.0	166	28646.0	167	25770.0	168	23194.0
169	20662.0	170	18044.0	171	15830.0	172	13578.0	173	11806.0	174	9910.0	175	8516.0	176	7169.0
177	6076.0	178	5167.0	179	4299.0	180	3746.0	181	3127.0	182	2653.0	183	2251.0	184	1975.0
185	1806.0	186	1570.0	187	1310.0	188	1196.0	189	1066.0	190	953.0	191	893.0	192	837.0
193	821.0	194	709.0	195	646.0	196	657.0	197	593.0	198	615.0	199	532.0	200	498.0
201	532.0	202	492.0	203	494.0	204	505.0	205	435.0	206	456.0	207	458.0	208	456.0
209	452.0	210	432.0	211	453.0	212	401.0	213	405.0	214	396.0	215	431.0	216	375.0
217	360.0	218	367.0	219	375.0	220	379.0	221	341.0	222	373.0	223	343.0	224	345.0

SHUTTER FUNCTION TRAPEZOID .186.628.186

INTERMEDIATE VALUES

STANDARD DEVIATION= .356E+02 DBETA= -.1306E+01 DVZRO= -.2933E-01
STANDARD DEVIATION= .347E+02 DBETA= -.1416E+00 DVZRO= -.5992E-07
STANDARD DEVIATION= .345E+02 DBETA= -.6896E-01 DVZRO= -.1272E-04
STANDARD DEVIATION= .345E+02 DBETA= -.3407E-01 DVZRO= -.6768E-05

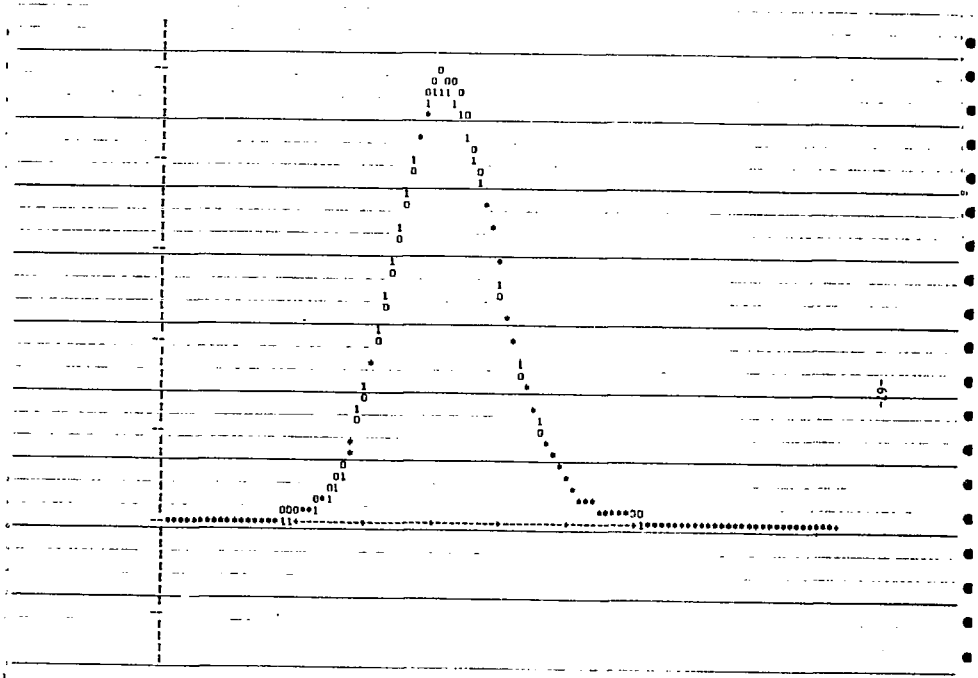
FINAL PARAMETER VALUES

BETA= .1175E+02 VZRO= .3803E+01 SPEED RATIO= .1304E+02 ALPHA= .2911E+00 ITERATIONS= 4 AVERAGE DEVIATION= 5.8
ESTIMATED ERROR IN LOCATION OF MINIMUM ON SURFACE IN BETA AND VZRO= .8331E-02 .2486E-03

C A L C U L A T E D D I S T R I B U T I O N

114	462.8	115	462.8	116	462.8	117	462.8	118	462.8	119	462.8	120	462.8	121	462.8
122	462.8	123	462.8	124	462.9	125	462.9	126	463.3	127	463.4	128	464.1	129	465.7
130	468.9	131	475.3	132	487.3	133	509.0	134	546.7	135	609.7	136	711.6	137	869.8
138	1108.2	139	1455.4	140	1944.7	141	2613.3	142	3499.3	143	4638.9	144	6262.3	145	7789.7
146	9827.0	147	12162.6	148	14765.2	149	17582.7	150	20544.2	151	23562.4	152	26538.8	153	29360.7
154	31992.5	155	34193.0	156	36010.7	157	37344.4	158	38155.0	159	38427.0	160	38158.4	161	37408.7
162	36195.6	163	34593.8	164	32665.8	165	30490.7	166	28163.4	167	25733.3	168	23271.8	169	23849.8
170	18507.5	171	16285.6	172	14212.9	173	12308.5	174	10587.9	175	9039.4	176	7675.2	177	6487.8
178	5451.6	179	4568.6	180	3819.4	181	3184.5	182	2644.1	183	2229.5	184	1872.6	185	1581.7
186	1346.1	187	1154.6	188	1005.2	189	884.8	190	789.5	191	714.9	192	654.4	193	613.9

194	575.7	195	548.5	196	527.7	197	511.7	198	499.6	199	490.4	200	483.4	231	478.2
202	474.2	203	471.3	204	469.1	205	467.4	206	466.2	207	465.3	208	464.4	209	464.7
210	463.8	211	463.5	212	463.3	213	463.2	214	463.1	215	463.0	216	463.0	217	462.9
218	462.9	219	462.9	220	462.9	221	462.9	222	462.8	223	462.8				



HE IN 30 PER C · · N2

MASS = 4.000
CHANNEL WIDTH =15.0 MICROSECONDS; BEGINNING CHANNEL = 51; ENDING CHANNEL =167; FLIGHT LENGTH =92.33 CM; IONIZER LENGTH = 1.00 CM.
OFFSET= -2.0 CHANNELS
WHEEL FREQ. =140. HZ; WHEEL DIAMETER =11.8 CM; SLOT WIDTH = .78 MM; DETECTOR APERTURE = .13 MM

INPUT DISTRIBUTION

51	22587.0	52	22438.0	53	22676.0	54	22848.0	55	22582.0	56	22731.0	57	22715.0	58	22420.0
59	22572.0	60	22644.0	61	22698.0	62	22746.0	63	22861.0	64	22977.0	65	22971.0	66	23006.0
67	23115.0	68	23120.0	69	23476.0	70	23745.0	71	23578.0	72	24143.0	73	24540.0	74	24910.0
75	25442.0	76	26211.0	77	27050.0	78	28651.0	79	29861.0	80	32407.0	81	35396.0	82	38259.0
83	44618.0	84	51788.0	85	60252.0	86	71588.0	87	86344.0	88	103482.0	89	124613.0	90	148447.0
91	175769.0	92	204685.0	93	233852.0	94	266209.0	95	299429.0	96	329633.0	97	361952.0	98	390139.0
99	419206.0	100	443173.0	101	466438.0	102	482133.0	103	493522.0	104	498572.0	105	501311.0	106	496337.0
107	486675.0	108	471641.0	109	452810.0	110	429786.0	111	433331.0	112	376397.0	113	347324.0	114	319860.0
115	290919.0	116	264926.0	117	242086.0	118	220418.0	119	200052.0	120	181138.0	121	163631.0	122	149501.0
123	133683.0	124	119489.0	125	106484.0	126	95366.0	127	87956.0	128	76558.0	129	68371.0	130	62030.0
131	56006.0	132	51471.0	133	47116.0	134	43543.0	135	40242.0	136	37221.0	137	36986.0	138	32419.0
139	31178.0	140	30035.0	141	28626.0	142	27540.0	143	26728.0	144	26267.0	145	25564.0	146	25045.0
147	24578.0	148	24412.0	149	24219.0	150	24083.0	151	23761.0	152	23675.0	153	23333.0	154	22873.0
155	23279.0	156	23150.0	157	23172.0	158	22837.0	159	22863.0	160	22964.0	161	22953.0	162	22645.0
163	22810.0	164	22644.0	165	22548.0	166	22712.0	167	22567.0						

SHUTTER FUNCTION TRAPEZOID .020,.960,.020

INTERMEDIATE VALUES

STANDARD DEVIATION=	.437E+03	DBETA=	.3188E-01	DVZRO=	-.4533E-01
STANDARD DEVIATION=	.329E+03	DBETA=	.5236E-01	DVZRO=	.2493E-02
STANDARD DEVIATION=	.299E+03	DBETA=	.2850E-01	DVZRO=	.9046E-03
STANDARD DEVIATION=	.291E+03	DBETA=	.1489E-01	DVZRO=	.4263E-03
STANDARD DEVIATION=	.289E+03	DBETA=	.7569E-02	DVZRO=	.2051E-03
STANDARD DEVIATION=	.289E+03	DBETA=	.3794E-02	DVZRO=	.9988E-04

FINAL PARAMETER VALUES

BETA= .1465E+01 VZRO= .5852E+01 SPEED RATIO= .7084E+01 ALPHA= .8261E+00 ITERATIONS= 6 AVERAGE DEVIATION= 16.7
ESTIMATED ERROR IN LOCATION OF MINIMUM ON SURFACE IN BETA AND VZRO= .4395E-03 .2139E-03

CALCULATED DISTRIBUTION

52	23176.4	53	23176.4	54	23176.4	55	23176.4	56	23176.4	57	23176.4	58	23176.4	59	23176.4
60	23176.4	61	23176.4	62	23176.4	63	23176.4	64	23176.4	65	23176.4	66	23176.4	67	23176.4
68	23176.4	69	23176.6	70	23176.9	71	23178.0	72	23181.2	73	23189.7	74	23210.4	75	23257.8
76	23359.2	77	23563.2	78	23950.6	79	24647.1	80	25837.1	81	27774.4	82	31788.1	83	35979.2
84	41705.1	85	50552.1	86	62294.6	87	77346.1	88	96004.8	89	118414.7	90	144505.6	91	173990.5
92	206352.0	93	240861.7	94	276617.3	95	312505.2	96	347713.6	97	380898.0	98	411145.3	99	437478.9
100	459491.5	101	476373.2	102	487924.4	103	494055.0	104	494868.3	105	490638.8	106	481781.4	107	468816.5

108	452336.1	109	432970.3	110	411357.1	111	388117.6	112	363835.6	113	339042.4	114	314237.2	115	289731.6
116	265947.8	117	243120.4	118	221450.3	119	231083.1	120	182131.2	121	164562.1	122	148440.4	123	133749.5
124	120514.9	125	108550.3	126	97830.8	127	88271.0	128	79788.8	129	72298.8	130	65686.2	131	59888.5
132	54819.5	133	50399.5	134	46726.3	135	43273.4	136	40343.9	137	37851.2	138	35737.3	139	33864.7
140	32292.5	141	30927.3	142	29768.0	143	28777.5	144	27932.5	145	27212.3	146	26599.2	147	26077.8
148	25634.7	149	25258.5	150	24939.3	151	24668.6	152	24439.3	153	24245.0	154	24080.5	155	23941.2
156	23823.4	157	23721.8	158	23639.5	159	23568.2	160	23508.3	161	23457.0	162	23413.9	163	23377.5
164	23346.7	165	23320.7	166	23298.7										

HE 660 PSI LONG FLIGHT PATH

MASS = 4.000
CHANNEL WIDTH = 5.0 MICROSECONDS; BEGINNING CHANNEL =151, ENDING CHANNEL =230; FLIGHT LENGTH =92.20 CM; IONIZER LENGTH = 1.00 CM.
OFFSET= -2.0 CHANNELS
WHEEL FREQ. =200. HZ; WHEEL DIAMETER =11.8 CM; SLOT WIDTH = .78 MM; DETECTOR APERTURE = .13 MM

INPUT DISTRIBUTION

151	58708.0	152	58727.0	153	59037.0	154	58649.3	155	58978.3	156	58772.0	157	59330.0	158	59488.0
159	58934.0	160	59297.0	161	59042.0	162	58827.0	163	58865.3	164	59099.0	165	59075.0	166	58966.0
167	59556.0	168	58809.0	169	58979.0	170	58908.0	171	59249.0	172	59202.0	173	59007.0	174	59374.3
175	58928.0	176	58765.0	177	59314.0	178	59311.0	179	59143.3	180	59786.0	181	59224.0	182	59286.0
183	58902.0	184	58843.0	185	59013.0	186	59742.0	187	59593.3	188	59691.0	189	60036.0	190	60701.0
191	62463.0	192	67548.0	193	77070.0	194	88348.0	195	96637.0	196	96168.0	197	83747.0	198	74405.0
199	66478.0	200	61168.0	201	60647.0	202	59834.0	203	59354.3	204	59034.0	205	59190.0	206	59371.0
207	59186.0	208	59333.0	209	58930.0	210	59462.0	211	59259.0	212	59011.0	213	59294.3	214	58986.3
215	58876.0	216	59295.0	217	59054.0	218	58404.0	219	59031.3	220	59033.0	221	59232.0	222	58883.3
223	58950.0	224	58985.0	225	59365.0	226	58944.0	227	58866.0	228	59105.0	229	58826.0	230	58873.0

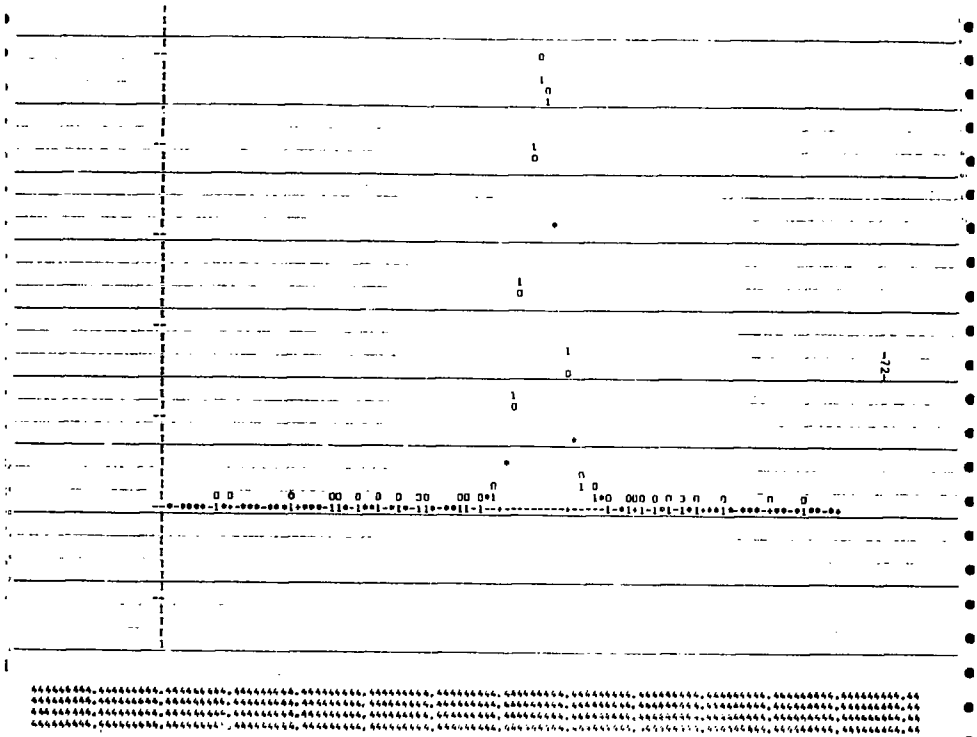
SHUTTER FUNCTION TRAPEZOID .262,476,262

INTERMEDIATE VALUES

STANDARD DEVIATION= .283E+01 DBETA= .2645E+01 DVZRO= .1367E-01

FINAL PARAMETER VALUES

BETA= .7548E+02 VZRO= .9567E+01 SPEED RATIO= .8311E+02 ALPHA= .1151E+00 ITERATIONS= 1 AVERAGE DEVIATION= 1.6
ESTIMATED ERROR IN LOCATION OF MINIUM ON SURFACE IN BETA AND VZRO= .1230E+00 .5634E-01

CALCULATED DISTRIBUTION

152	59103.7	153	59103.7	154	59103.7	155	59103.7	156	59133.7	157	59103.7	158	59103.7	159	59133.7
160	59103.7	161	59103.7	162	59103.7	163	59133.7	164	59133.7	165	59103.7	166	59103.7	167	59103.7
168	59103.7	169	59103.7	170	59103.7	171	59103.7	172	59133.7	173	59103.7	174	59103.7	175	59133.7
176	59103.7	177	59103.7	178	59103.7	179	59133.7	180	59103.7	181	59103.7	182	59133.7	183	59133.7
184	59103.7	185	59133.7	186	59103.7	187	59135.0	188	59120.1	189	59238.7	190	59869.5	191	62169.5
192	67567.6	193	77987.4	194	89234.3	195	95543.7	196	92765.8	197	82946.5	198	72360.9	199	64497.3
200	60818.6	201	59518.9	202	59180.1	203	59114.3	204	59134.8	205	59133.8	206	59133.7	207	59103.7
208	59103.7	209	59103.7	210	59103.7	211	59103.7	212	59133.7	213	59103.7	214	59133.7	215	59103.7
216	59103.7	217	59133.7	218	59103.7	219	59133.7	220	59133.7	221	59133.7	222	59133.7	223	59103.7
224	59103.7	225	59103.7	226	59103.7	227	59103.7	228	59103.7	229	59103.7