COMPUTER PROGRAMS FOR REDUCING QUARTZ GAGE, VELOCITY AND TILT RECORDS

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Abstract

This report documents computer programs for quartz gage data reduction, projectile velocity data reduction, and tilt data reduction.

Quartz Gage Reduction

The quartz gage data reduction programs in my WYLBUR file are (1) #NOPLOT, (2) #QRTZPLHG, (3) #QRTPLALL, and (4) QRTZPLSH.

#NOPLOT reduces current-time profiles of shorted gages yielding stress-time data pairs without and with ramping correction. It does not produce plots. #QRTZPLHG does the same thing but also plots the profiles. Current coefficients A and B and ramping correction ALPHA are entered as variables near the beginning of the program. For the Hayes-Gupta calibration of our shorted gage $A = 1.89 \times 10^{-8}$ C/cm^2 kbar and $B = 0.0107 \times 10^{-8}$ C/cm^2 kbar^2. ALPHA = 0.41/μsec above about 15 kbar and 0.26/μsec below it. A sample program and data set are shown.

#QRTZPLALL is a modification of the program QRTZPLSH allowing you to plot several records on the same plot. This modification can readily be done to #QRTZPLHG also.

QRTZPLSH is a revision for use with shunted gages. Here $A = 2.00 \times 10^{-8}$ and $B = 0.0097 \times 10^{-8}$ and ALPHA is submitted with the data set since, according to Bob Graham of Sandia, ALPHA = $(0.011 + 0.0035\ P_x)U/1$ for these gages. The program has been cleaned up somewhat, also.

On WYLBUR, I have an execute file to run data sets, #EXFRTPLQ.

JCL

```
? USE #JCLP1 CLE
1.      //JJD JØB (,9S),'JERRY DICK',MSGLEVEL=(1,1),CLASS=A
2.      /*RESØURCE PLØTTER
3.      //. EXEC PLØTLKGØ,PEN=A,FØRM=CO
4.      //FØRT.SYSIN DD *
```

```
? USE #EXFRTPLO CLE
? .5 SET ESC %
? L
0.5     SET ESC %
1.      COPY FROM #JCLP1
2.      COPY FROM #ORIZPLHG
2.5     READ VALUE SO
3.      COPY FRØM #ØRT%SO
4.      RUN TERMINAL PRIØRITY=B
? X ACT CLE
ENTER? 4309
```

- JCL
- PROGRAM
- DATA SET #QRT----

```
      DIMENSION TSA(1CC),ASA(1CC),ASB(100),CAL(50)
      DIMENSIONTIM(100),PRESS(1CC),TITLE1(10),TITLE2(10),P(100)
      DIMENSION XX(5C),YY(50),CLR(50),TT(50),X(100),Y(100)
      DATA TITLE1/'PRES','SURE',' (K','B) '/
      DATA TITLE2/'RAMP','ING ','ADJU','STED',' PRE',
     1'SSUR','E (K','B) '/
      ELL=2.623
   10 FORMAT(I5,12HTIMING MARKS)
   11 FORMAT(4X,F6.3,1CX,F6.3)
   12 FORMAT(I5,17HCALIBRATION MARKS)
   22 FORMAT(2X,'DEFLECTION',8X,'CURRENT'/5X,'(MM)',11X,'(AMPS)')
   13 FORMAT(4X,F6.3,1CX,F8.5)
   20 FORMAT(1X,'GAUGE THICKNESS=',E11.4,5X,'AREA=',E11.4)
   21 FORMAT(1X,'DEFLECTION                TIME'/4X,'(MM)',9X,'(MICROSECS)')
   23 FORMAT(1X,'STD DEVIATION=',F06.2,'PERCENT')
   24 FORMAT(1X,//5X,'STRESS',8X,'TIME',8X,'X',13X,'Y',9X,
     1'CURRENT'/5X,'(KBAR)',5X,'(MICROSECS)',3X,'(MM)',
     28X,'(MM  )',8X,'(AMPS)')
   25 FORMAT(3I3)
   26 FORMAT(C8F7.3)
   27 FORMAT(2E12.5)
   28 FORMAT(08F7.4)
   51 FORMAT(3X,F8.3,5X,F8.3,3X,F8.3,5X,F8.3,5X,F8.3)
   61 FORMAT(5F12.3)
   62 FORMAT(1X,//7X,'STRESS',6X,'TIME',2X,'CORRECTED CURRENT',
     +2X,'CURRENT',3X,'TIME/2.623')
   77 FORMAT(I2,I3,I2)
   88 FORMAT(20X,'SHOT  ',I2,'-',I3,'-',I2,/)
  111 FORMAT(1X,//20X,'A =',E12.5,/20X,'B =',E12.5,//)
  112 FORMAT(1X,/5X,'ALFA=',E12.5/)
      A=2.0CCCE-8
      B=C9.70CE-11
      STP=0.0
      ASA(1)=C.
      TSA(1)=C.
      ASB(1)=0.
      READ(5,77)II,JJ,KK
      WRITE(6,88)II,JJ,KK
      READ(5,25)NT,NCAL,NP
      READ(5,26)(XX(I),TT(I),I=1,NT)
      READ(5,28)(YY(I),CLR(I),I=1,NCAL)
      READ(5,26)(X(I),Y(I),I=1,NP)
      READ(5,27)TH,AR
      READ (5,26) ALFA
      WRITE(6,20)TH,AR
      PRINT 10,NT
      WRITE(6,21)
      PRINT 11,(XX(I),TT(I),I=1,NT)
C       FIND STANDARD DEVIATIONS OF TIMING MARKS
      NTT=NT-1
      CALL STDDEV(TT,XX,NTT,STP)
      WRITE(6,23) STP
      PRINT 12,NCAL
      WRITE(6,22)
      NKAL=NCAL-1
      PRINT 13,(YY(I),CLR(I),I=1,NCAL)
      SUM=0.
C     FIND STANDARD DEVIATION OF CALIBRATION CURRENTS.
```



```
C
      CALL STDDEV(CUR,YY,NKAL,STP)
      WRITE(6,23) STP
      WRITE(6,111)A,B
      WRITE(6,24)

C     DATA REDUCTION.
      DO 30 I=1,NP
C    TIME REDUCTION.
      DO 31 J=2,NT
      K=J
  101 IF(XX(J)-X(I)) 31,24,34
   31 CONTINUE
   34 TIM(I)=TT(K)+(TT(K)-TT(K-1))/(XX(K)-XX(K-1))*(X(I)-XX(K))
```

```
C     CURRENT REDUCTION.
      DO 41 J=2,NCAL
      K=J
  201 IF(YY(J)-Y(I)) 41,44,44
   41 CONTINUE
   44 TA=(CUR(K)-CUR(K-1))/(YY(K)-YY(K-1))
      AMP=CUR(K)+TA*(Y(I)-YY(K))
      IF(I-1) 49,50,49
   50 AS=AMP
      TS=TIM(I)
   49 AMP=AMP-AS
      TIM(I)=TIM(I)-TS
      AOB=-A/(2.*B)
      PRESS(I)=AOB+(AOB**2+AMP*TH/(AR*5.72E5*B))**0.5
      PRINT 51,PRESS(I),TIM(I),X(I),Y(I),AMP
      TSA(I+1)=TIM(I)
      ASA(I+1)=AMP
   30 CONTINUE
      AA=II
      BB=JJ
      CC=KK
      CALL SYMBOL(1.,4.,.21,'SHOT   -    -   ',90.,14)
      CALL NUMBER(1.,4.64,.21,AA,90.,-1)
      CALL NUMBER(1.,5.49,.21,BB,90.,-1)
      CALL NUMBER(1.,6.31,.21,CC,90.,-1)
      CALL PLOT(2.,0.,-3)
      CALL MYPLOT(TIM,PRESS,NP,TITLE1,16)
      WRITE(6,62)
      ENT=0.
C     RAMPING CORECTION TO CURRENT.   CF.  D.B. Hayes' Thesis
      WRITE (6,112) ALFA
      NPP=NP+1
      DO 60 I=2,NPP
      DTT=(TSA(I)-TSA(I-1))/2.
      TTT=ASA(I)-ALFA*ENT-ALFA*DTT*ASB(I-1)
      SCT=TSA(I)/ELL
      ASB(I)=TTT/(1.+ALFA*DTT)
      ENT=ENT+(ASB(I)+ASB(I-1))*DTT
      PRESS(I)=AOB+(AOB**2+ASB(I)*TH/(AR*5.72E5*B))**.5
      P(I-1)=PRESS(I)
   60 PRINT 61,PRESS(I),TSA(I),ASB(I),ASA(I),SCT
      CALL MYPLOT(TIM,P,NP,TITLE2,32)
      STOP
      END
```

IV G LEVEL 21 STDDEV DATE = 77105 14/37/06

```
      SUBROUTINE STDDEV(CUR,YY,NKAL,STP)
      DIMENSION CUR(50),YY(50),CAL(50)
      SUM=0.0
      DO 90 I=1,NKAL
      CAL(I)=(CUR(I+1)-CUR(I))/(YY(I+1)-YY(I))
   90 SUM=SUM+CAL(I)
      CALAVE=SUM/NKAL
      SAM=0.
      DO 91 I=1,NKAL
   91 SAM=SAM+(CAL(I)-CALAVE)**2
      STDDEV=SQRT(SAM/(NKAL-1.))
      STP=100.0*STDDEV/CALAVE
      RETURN
      END
```

IV G LEVEL 21 MYPLOT DATE = 77105 14/37/06

```
      SUBROUTINE MYPLOT(X,Y,N,TITLE,M)
      DIMENSION X(100),Y(100),TITLE(10)
      CALL PLOT(1.,.5,-3)
      Y(N+1)=0.0
      Y(N+2)=4.0
      X(N+1)=0.0
      X(N+2)=0.10
      CALL AXIS(0.,0.,15HTIME (MICROSEC),-15,12.,0.,
     10.0,0.10)
      CALL AXIS(0.,0.,TITLE,M,10.,90.,0.0,4.0)
      CALL LINE(X,Y,N,1,0,0)
      CALL PLOT(12.,-11.,-3)
      RETURN
      END
```

```
    1.      //G0.SYSIN DD *
    2.      7701921
    3.      007009012
    4.       04.623 00.000 11.479 00.500 18.446 01.000 25.355 01.500
    5.       32.384 02.000 39.450 02.500 46.517 03.000
    6.      26.818 00.000028.098 00.050029.420 00.100030.728 00.1500
    7.      32.017 00.200033.360 00.250034.705 00.300036.020 00.3500
    8.      37.359 00.4000
    9.       08.350 26.886 09.302 37.578 09.515 37.668 09.735 37.717
   10.       10.223 37.670 10.707 37.526 11.204 37.167 12.167 36.455
   11.       12.950 35.980 17.071 36.973 18.678 37.446 20.690 37.976
   12.      00.63800E+00 01.25300E+00
   13.       00.073
? SAV #ORT1921
MEMBER ORT1921 SAVED IN LIB
   15.
? DEL 14
? L*CH )*'9' T0 '8' IN 3
    3.      007008013
? L
    1.      //G0.SYSIN DD *
    2.      7701922
    3.      007008013
    4.       04.552 00.000 11.405 00.500 18.344 01.000 25.230 01.500
    5.       32.222 02.000 39.175 02.500 46.184 03.000
    6.      16.066 00.000017.558 00.050019.049 00.100020.549 00.1500
    7.      22.079 00.200023.570 00.250025.090 00.300028.142 00.4000
    8.       29.223 16.180 29.576 16.581 29.690 16.698 29.936 16.986
    9.       30.833 22.521 31.082 23.189 31.467 23.654 32.020 24.043
   10.       32.654 24.284 34.820 24.668 38.994 25.183 41.915 25.680
   11.       44.348 26.130
   12.      00.63450E+00 01.24880E+00
   13.       00.073
? SAV #ORT1922
MEMBER ORT1922 SAVED IN LIB
? USE #EXFRTPLO CLE
? X ACT CLE
ENTER? 1922
ACC0UNT?
********
J0B --    443 JJD      SENT T0 HASP.
J0B   443 --    AWAITING EXEC     A $A 168
EXEC END
? L0C *-2
J0B 00358 --    AWAITING EXEC     A $A 102
? L0C *-3
J0B 00284 --   N0T L0CATABLE
? L0C *=4
J0BNAME JJDPY896 INC0RRECT
REQUEST AB0RTED.
? L0C *-4
J0B 00259 -- READY F0R FETCH
? FET *-4 SAV
0K T0 CLEAR? 0K
QUEUED
```

#QRT 1921 3-9-77

Timing Meake

Current Calibration

Data Pairs

Gauge Thickness and Area - cm

Ramping Correction Factor

QRT1922 3-9-77

```
IV G LEVEL  21                    MAIN                    DATE = 76135          14/08/54

      DIMENSION TSA(100),ASA(100),ASB(100)                                          1
      DIMENSION TIM(100),PRESS(100),TITLE1(10),TITLE2(10),P(100)                    2
      DIMENSION XX(50),YY(50),CUR(50),TT(50),X(100),Y(100)                          3
      DATA TITLE1/'PRES','SURE','  (K','B)  '/                                      4
      DATA TITLE2/'RAMP','ING ','ADJU','STED',' PRE',                               5
     1'SSUR','E (K','B)  '/                                                         6
      ELL=2.623                                                                     7
   25 FORMAT(3I3)                                                                   8
   26 FORMAT(08F7.3)                                                                9
   28 FORMAT(08F7.4)                                                               10
   27 FORMAT(2E12.5)                                                               11
      A=1.8900E-8                                                                  12
      B=10.700E-11                                                                 13
      ALFA=0.41                                                                    14
      ASA(1)=0.                                                                    15
      TSA(1)=0.                                                                    16
      ASB(1)=0.                                                                    17
      READ(5,77)II,JJ,KK                                                           18
      WRITE(6,88)II,JJ,KK                                                          19
   88 FORMAT(20X,'SHOT  ',I2,'-',I3,'-',I2,/)                                      20
   77 FORMAT(I2,I3,I2)                                                             21
      READ(5,25)NT,NCAL,NP                                                         22
      READ(5,28)(YY(I),CUR(I),I=1,NCAL)                                            23
      READ(5,26)(XX(I),TT(I),I=1,NT)                                               24
      READ(5,26)(X(I),Y(I),I=1,NP)                                                 25
      READ(5,27)TH,AR                                                              26
   20 FORMAT(1X,'GAUGE THICKNESS=',E11.4,5X,'AREA=',E11.4)                         27
      WRITE(6,20)TH,AR                                                             28
      PRINT 10,NT                                                                  29
   10 FORMAT(I5,12HTIMING MARKS)                                                   30
   21 FORMAT(1X,'DEFLECTION          TIME'/4X,'(MM)',9X,'(MICROSECS)')             31
      WRITE(6,21)                                                                  32
      PRINT 11,(XX(I),TT(I),I=1,NT)                                                33
   11 FORMAT(4X,F6.3,10X,F6.3)                                                     34
      PRINT 12,NCAL                                                                35
   12 FORMAT(I5,17HCALIBRATION MARKS)                                              36
   22 FORMAT(2X,'DEFLECTION',8X,'CURRENT'/5X,'(MM)',11X,'(AMPS)')                  37
      WRITE(6,22)                                                                  38
      NKAL=NCAL-1                                                                  39
      PRINT 13,(YY(I),CUR(I),I=1,NCAL)                                             40
      SUM=0.                                                                       41
C       FIND STANDARD DEVIATION OF CALIBRATION CURRENTS.                           42
C                                                                                  43
      DO 90 I=1,NKAL                                                               44
   90 SUM=SUM+YY(I+1)-YY(I)                                                        45
      SUM=SUM/NKAL                                                                 46
      SAM=0.                                                                       47
      DO 91 I=1,NKAL                                                               48
   91 SAM=SAM+(YY(I+1)-YY(I)-SUM)**2                                               49
      STP=100.*SQRT(SAM/(NKAL-1))/SUM                                              50
   23 FORMAT(1X,'STD DEVIATION=',E11.4,'PERCENT')                                  51
      WRITE(6,23) STP                                                              52
      WRITE(6,111)A,B                                                              53
  111 FORMAT(1X,//20X,'A =',E12.5,/20X,'B =',E12.5,//)                             54
   13 FORMAT(4X,F6.3,10X,F8.5)                                                     55
   24 FORMAT(1X,//5X,'STRESS',8X,'TIME',8X,'X',13X,'Y',9X,                         56
     1'CURRENT'/5X,'(KBAR)',5X,'(MICROSECS)',3X,'(MM)',                            57
     28X,'(AMPS)',8X,'(KBAR)')                                                     58
```

QRTZPLHG

5-14-76

Year Shot # Scope #

NT = # of Timing Marks NCAL = # of Vertical Calibration Lines

Data Pairs

I LEVEL 21 MAIN DATE = 76135 14/08/54

```
      WRITE(6,24)                                                       59.
      CAY=TH/(AR*5.72E5)                                                60.
C     DATA REDUCTION.                                                   61.
      DO 30 I=1,NP                                                      62.
C    TIME REDUCTION.                                                    63.
      DO 31 J=2,NT                                                      64.
      K=J                                                               65.
101   IF(XX(J)-X(I)) 31,34,34                                           66.
31    CONTINUE                                                          67.
34    TIM(I)=TT(K)+(TT(K)-TT(K-1))/(XX(K)-XX(K-1))*(X(I)-XX(K))         68.
C    CURRENT REDUCTION.                                                 69.
      DO 41 J=2,NCAL                                                    70.
      K=J                                                               71.
201   IF(YY(J)-Y(I)) 41,44,44                                           72.
41    CONTINUE                                                          73.
44    TA=(CUR(K)-CUR(K-1))/(YY(K)-YY(K-1))                              74.
      AMP=CUR(K)+TA*(Y(I)-YY(K))                                        75.
      IF(I-1) 49,50,49                                                  76.
50    AS=AMP                                                            77.
      TS=TIM(I)                                                         78.
49    AMP=AMP-AS                                                        79.
      TIM(I)=TIM(I)-TS                                                  80.
      AOB=-A/(2.*B)                                                     81.
      PRESS(I)=AOB+(AOB**2+AMP*TH/(AR*5.72E5*B))**0.5                   82.
      PRINT 51,PRESS(I),TIM(I),X(I),Y(I),AMP                            83.
      TSA(I+1)=TIM(I)                                                   84.
      ASA(I+1)=AMP                                                      85.
51    FORMAT(3X,F8.3,5X,F8.3,3X,F8.3,5X,F8.3,5X,F8.3)                   86.
30    CONTINUE                                                          87.
      AA=II                                                             88.
      BB=JJ                                                             89.
      CC=KK                                                             90.
      CALL SYMBOL(1.,4.,.21,'SHOT   -   -  ',90.,14)                    91.
      CALL NUMBER(1.,4.84,.21,AA,90.,-1)                                92.
      CALL NUMBER(1.,5.49,.21,BB,90.,-1)                                93.
      CALL NUMBER(1.,6.31,.21,CC,90.,-1)                                94.
      CALL PLOT(2.,0.,-3)                                               95.
      CALL MYPLOT(TIM,PRESS,NP,TITLE1,16)                               96.
      WRITE(6,62)                                                       97.
62    FORMAT(1X,//7X,'STRESS',6X,'TIME',2X,'CORRECTED CURRENT',         98.
     +2X,'CURRENT',3X,'TIME/2.623')                                     99.
      ENT=0.                                                           100.
C     RAMPING CORECTION TO CURRENT.                                    101.
      CALL MAXIMU(PRESS,NP,PMAX)                                       102.
      IF (PMAX.LT.13) ALFA=0.26                                        103.
      WRITE(6,112) ALFA                                                104.
112   FORMAT(1X,/5X,'ALFA=',E12.5/)                                    105.
      NPP=NP+1                                                         106.
      DO 60 I=2,NPP                                                    107.
      DTT=(TSA(I)-TSA(I-1))/2.                                         108.
      TTT=ASA(I)-ALFA*ENT-ALFA*DTT*ASB(I-1)                            109.
      SCT=TSA(I)/ELL                                                   110.
      ASB(I)=TTT/(1.+ALFA*DTT)                                         111.
      ENT=ENT+(ASB(I)+ASB(I-1))*DTT                                    112.
      PRESS(I)=AOB+(AOB**2+ASB(I)*TH/(AR*5.72E5*B))**.5                113.
      P(I-1)=PRESS(I)                                                  114.
60    PRINT 61,PRESS(I),TSA(I),ASB(I),ASA(I),SCT                       115.
61    FORMAT(5F12.3)                                                   116.
```

```
N IV G LEVEL  21                 MAIN                DATE = 76135         14/08/54

          CALL MYPLOT(TIM,P,NP,TITLE2,32)
          STOP
          END

N I. G LEVEL  21                 MAXIMU              DATE = 76135         14/08/54

          SUBROUTINE MAXIMU(P,NP,PMAX)
          DIMENSICN P(100)
          PMAX=P(1)
          DO 950 I=2,NP
          IF (P(I).GT.PMAX) PMAX=P(I)
      950 CONTINUE
          RETURN
          END

N IV G LEVEL  21                 MYPLOT              DATE = 76135         14/08/54

          SUBROUTINE MYPLOT(X,Y,N,TITLE,M)
          DIMENSICN X(100),Y(100),TITLE(10)
          CALL PLCT(1.,.5,-3)
          Y(N+1)=0.0
          Y(N+2)=4.0
          X(N+1)=0.0
          X(N+2)=0.05
          CALL AXIS(0.,0.,15HTIME (MICROSEC),-15,12.,0.,
         10.0,0.05)
          CALL AXIS(0.,0.,TITLE,M,10.,90.,0.0,4.0)
          CALL LINE(X,Y,N,1,0,0)
          CALL PLCT(12.,-11.,-3)
          RETURN
          END
```

```
//GØ.SYSIN DD *
7506808
010005077
14.254 0.0000 17.384 0.0100 20.402 0.0199 26.765 0.0399
29.832 0.0499
00.878 00.000 06.024 00.100 10.950 00.200 14.980 00.300
21.027 00.400 26.076 00.500 31.141 00.600 36.125 00.700
41.185 00.800 46.081 00.900
02.799 13.891 02.799 13.891 03.070 20.029 03.275 24.991
03.484 27.848 03.652 28.319 03.937 28.725 04.384 28.981
04.675 29.053 04.988 29.123 05.218 29.179 05.411 29.216
05.624 29.261 05.852 29.285 06.023 29.309 06.209 29.297
06.384 29.299 06.568 29.318 06.711 29.328 06.926 29.343
07.120 29.351 07.340 29.366 07.500 29.376 07.800 29.407
08.100 29.425 08.400 29.434 08.700 29.468 09.000 29.480
09.300 29.488 09.600 29.517 09.900 29.523 10.200 29.557
10.500 29.577 10.800 29.583 11.100 29.619 11.400 29.642
11.700 29.663 12.000 29.676 12.300 29.692 12.600 29.726
12.900 29.751 13.200 29.772 13.500 29.800 13.800 29.819
14.100 29.842 14.400 29.873 14.700 29.908 15.000 29.938
15.500 30.019 16.000 30.071 16.500 30.084 17.000 30.116
17.500 30.173 18.000 30.225 18.500 30.265 19.000 30.317
19.500 30.381 20.000 30.398 20.500 30.435 21.000 30.479
21.500 30.519 22.000 30.564 22.500 30.606 23.000 30.642
23.500 30.675 24.000 30.719 24.500 30.745 25.000 30.792
25.500 30.809 26.000 30.844 26.500 30.880 27.000 30.932
27.500 30.950 28.000 30.983 28.500 31.025 29.000 31.054
29.500 31.091
0.31927E+00 0.10240E+00
? LØC 332 RER
JØB 00332 -- READY FØR FETCH
? FET 332 RER SAA-V CLE
? RØU 332 RER LØC
? L 210/L UNN
```

~~#RR75068A~~ For GRT2PLHG on MYPLOT (?) — 75068 - Scope 8

(lines 4–5) Current Calibration

(lines 6–8) Timing Mark's

(lines 9–28) Data Pairs

(line 29) Gage Thickness and Acc - cm (?)

QRTPLALL 3-9-77 #686

N G LEVEL 21 MAIN DATE = 77068 19/19/32

```
      DIMENSION TSA(100),ASA(100),ASB(100),CAL(50)                      1.
      DIMENSIONTIM(100),PRESS(100),TITLE1(10),TITLE2(10),P(100)         2.
      DIMENSION XX(50),YY(50),CUR(50),TT(50),X(100),Y(100)              3.
      DATA TITLE1/'PRES','SURE','  (K','B)  '/                          4.
      DATA TITLE2/'RAMP','ING ','ADJU','STED',' PRE',                   5.
     1'SSUR','E (K','B)  '/                                             6.
      FLI=2.623          AR                                             7.
   25 FORMAT(3I3)                                                       8.
   26 FORMAT(08F7.3)                                                    9.
   28 FORMAT(08F7.4)                                                    10.
   27 FORMAT(2E12.5)                                                    11.
      A=2.0000E-6                                                       12.
      B=09.700E-11                                                      13.
      ASA(1)=0.                                                         14.
      TSA(1)=0.                                                         15.
      ASB(1)=0.                                                         16.
      CALL PLOT(1.,.5,-3)                                               17.
      CALL AXIS(0.,0.,15HTIME (MICROSEC),-15,12.,0.,                    18.
     10.0,0.50)                                                         19.
      CALL AXIS(0.,0.,TITLE2,M,10.,90.,0.0,10.0)                        20.
      CALL SYMBOL(1.,4.,.21,'SHOT   -   -  ',90.,14)                    21.
      CALL NUMBER(1.,4.84,.21,AA,90.,-1)                                22.
      CALL NUMBER(1.,5.49,.21,BB,90.,-1)                                23.
      CALL NUMBER(1.,6.31,.21,CC,90.,-1)                                24.
      READ (5,77) NDS                                                   25.
      DO 600 II=1,NDS                                                   26.
      READ(5,77)II,JJ,KK                                                27.
      WRITE(6,88)II,JJ,KK                                               28.
   88 FORMAT(20X,'SHOT  ',I2,'-',I3,'-',I2,/)                           29.
   77 FORMAT(I2,I3,I2)                                                  30.
      READ(5,25)NT,NCAL,NP                                              31.
      READ(5,26)(XX(I),TT(I),I=1,NT)                                    32.
      READ(5,26)(YY(I),CUR(I),I=1,NCAL)                                 33.
      READ(5,26)(X(I),Y(I),I=1,NP)                                      34.
      READ(5,27)TH,AR                                                   35.
      READ (5,26) ALFA                                                  36.
   20 FORMAT(1X,'GAUGE THICKNESS=',E11.4,5X,'AREA=',E11.4)              37.
      WRITE(6,20)TH,AR                                                  38.
      PRINT 10,NT                                                       39.
   10 FORMAT(I5,12HTIMING MARKS)                                        40.
   21 FORMAT(1X,'DEFLECTION          TIME'/4X,'(MM)',9X,'(MICROSECS)')  41.
      WRITE(6,21)                                                       42.
      PRINT 11,(XX(I),TT(I),I=1,NT)                                     43.
   11 FORMAT(4X,F6.3,10X,F6.3)                                          44.
      PRINT 12,NCAL                                                     45.
   12 FORMAT(I5,17HCALIBRATION MARKS)                                   46.
   22 FORMAT(2X,'DEFLECTION',8X,'CURRENT'/5X,'(MM)',11X,'(AMPS)')       47.
      WRITE(6,22)                                                       48.
      NKAL=NCAL-1                                                       49.
      PRINT 13,(YY(I),CUR(I),I=1,NCAL)                                  50.
      SUM=0.                                                            51.
C      FIND STANDARD DEVIATION OF CALIBRATION CURRENTS.                 52.
C                                                                       53.
      DO 90 I=1,NKAL                                                    54.
      CAL(I)=(CUR(I+1)-CUR(I))/(YY(I+1)-YY(I))                          55.
   90 SUM=SUM+CAL(I)                                                    56.
      CALAVE=SUM/NKAL                                                   57.
      SAM=0.                                                            58.
```

Put these before L93 until a IF (II.NE.1) GO TO

```
      DO 91 I=1,NKAL                                                    59
   91 SAM=SAM+(CAL(I)-CALAVE)**2                                        60
      STDDEV=SQRT(SAM/(NKAL-1.))                                        61
      STP=100.0*STDDEV/CALAVE                                           62
   23 FORMAT(1X,'STD DEVIATION=',F06.2,'PERCENT')                       63
      WRITE(6,23) STP                                                   64
      WRITE(6,111)A,B                                                   65
  111 FORMAT(1X,//20X,'A =',E12.5,/20X,'B =',E12.5,//)                  66
   13 FORMAT(4X,F6.3,10X,F8.5)                                          67
   24 FORMAT(1X,//5X,'STRESS',8X,'TIME',8X,'X',13X,'Y',9X,              68
     1'CURRENT'/5X,'(KBAR)',5X,'(MICROSECS)',3X,'(MM)',                 69
     28X,'(AMPS)',8X,'(KBAR)')                                          70
      WRITE(6,24)                                                       71
      CAY=TH/(AR*5.72E5)                                                72
C     DATA REDUCTION.                                                   73
      DO 30 I=1,NP                                                      74
C    TIME REDUCTION.                                                    75
      DO 31 J=2,NT                                                      76
      K=J                                                               77
  101 IF(XX(J)-X(I)) 31,34,34                                           78
   31 CONTINUE                                                          79
   34 TIM(I)=TT(K)+(TT(K)-TT(K-1))/(XX(K)-XX(K-1))*(X(I)-XX(K))         80
C    CURRENT REDUCTION.                                                 81
      DO 41 J=2,NCAL                                                    82
      K=J                                                               83
  201 IF(YY(J)-Y(I)) 41,44,44                                           84
   41 CONTINUE                                                          85
   44 TA=(CUR(K)-CUR(K-1))/(YY(K)-YY(K-1))                              86
      AMP=CUR(K)+TA*(Y(I)-YY(K))                                        87
      IF(I-1) 49,50,49                                                  88
   50 AS=AMP                                                            89
      TS=TIM(I)                                                         90
   49 AMP=AMP-AS                                                        91
      TIM(I)=TIM(I)-TS                                                  92
      AOB=-A/(2.*B)                                                     93
      PRESS(I)=AOB+(AOB**2+AMP*TH/(AR*5.72E5*B))**0.5                   94
      PRINT 51,PRESS(I),TIM(I),X(I),Y(I),AMP                            95
      TSA(I+1)=TIM(I)                                                   96
      ASA(I+1)=AMP                                                      97
   51 FORMAT(3X,F8.3,5X,F8.3,3X,F8.3,5X,F8.3,5X,F8.3)                   98
   30 CONTINUE                                                          99
      AA=II                                                            100
      BB=JJ                                                            101
      CC=KK                                                            102
      WRITE(6,62)                                                      103
   62 FORMAT(1X,//7X,'STRESS',6X,'TIME',2X,'CORRECTED CURRENT',        104
     +2X,'CURRENT',3X,'TIME/2.623')                                    105
      ENT=0.                                                           106
C    RAMPING CORECTION TO CURRENT.                                     107
      WRITE (6,112) ALFA                                               108
  112 FORMAT(1X,/5X,'ALFA=',E12.5/)                                    109
      NPP=NP+1                                                         110
      DO 60 I=2,NPP                                                    111
      DTT=(TSA(I)-TSA(I-1))/2.                                         112
      TTT=ASA(I)-ALFA*ENT-ALFA*DTT*ASB(I-1)                            113
      SCT=TSA(I)/ELL                                                   114
      ASB(I)=TTT/(1.+ALFA*DTT)                                         115
      ENT=ENT+(ASB(I)+ASB(I-1))*DTT                                    116
```

```
IV G LEVEL  21                    MAIN                    DATE = 77068          19/19/32

      PRESS(I)=A0B+(A0B**2+ASB(I)*TH/(AR*5.72E5*8))**.5                              117
      P(I-1)=PRESS(I)                                                                118
   60 PRINT 61,PRESS(I),TSA(I),ASB(I),ASA(I),SCT                                     119
   61 FORMAT(5F12.3)                                                                 120
      CALL MYPLOT(TIM,P,NP,TITLE2,32)                                                121
  600 CONTINUE                                                                       122
      STOP                                                                           123
      END                                                                            124
```

```
IV G LEVEL  21                    MYPLOT                  DATE = 77068          19/19/32

      SUBROUTINE MYPLOT(X,Y,N,TITLE,M)                                               125.
      DIMENSION X(100),Y(100),TITLE(10)                                              126.
      Y(N+1)=0.0                                                                     127.
      Y(N+2)=10.0                                                                    128.
      X(N+1)=0.0                                                                     129.
      X(N+2)=0.50                                                                    130.
      CALL LINE(X,Y,N,1,0,0)                                                         131.
      RETURN                                                                         132.
      END                                                                            133.
```

12

DATALL

12/8/75

```
USE DATALL
? L
   1.      //G0.SYSIN DD *                                  Modeled on
   2.      07 ~~~~. #OF DATASETS                            ORTEPLIG
   3.      7503610
   4.      007004029
   5.       10.017  0.000 17.369  0.025 25.120  0.050 40.437  0.100
   6.        4.847  0.000 19.530  0.150 24.600  0.200 29.662  0.250
   7.       34.732  0.300 39.748  0.350 44.743  0.400
   8.       19.800  7.888 20.892 30.354 21.005 30.492 21.122 30.530
   9.       21.362 30.335 21.584 29.948 22.114 28.994 22.830 27.504
  10.       23.635 25.774 24.594 23.884 24.594 23.884 25.769 21.593
  11.       26.412 20.895 27.618 19.551 28.472 18.999 29.635 18.534
  12.       30.656 18.400 31.566 18.493 32.980 18.979 34.860 20.149
  13.       36.776 21.945 38.700 24.384 41.144 28.356 42.420 30.530
  14.       44.296 33.542 45.656 35.340 47.151 36.823 48.750 37.995
  15.       50.656 38.768
  16.      0.31750E+00 0.09923E+00
  17.      7504010
  18.      007005030
  19.        7.678  0.000 15.448  0.025 23.334  0.050 31.361  0.075
  20.       39.158  0.100
  21.       15.069  0.000 20.179  0.050 25.423  0.100 30.654  0.150
  22.       35.922  0.200 41.164  0.250 46.523 00.300
  23.       15.990  7.963 15.990  7.963 15.990  7.963 15.990  7.963
  24.       16.386 28.161 16.506 28.679 16.632 28.849 16.797 28.841
  25.       17.008 28.734 17.162 28.584 17.358 28.344 18.021 27.318
  26.       18.870 25.974 19.505 24.889 20.706 22.748 21.773 21.207
  27.       23.631 19.072 25.555 17.760 27.530 17.317 29.449 17.624
  28.       31.776 18.710 34.078 20.471 36.301 22.973 39.145 27.343
  29.       40.335 29.192 41.673 31.238 43.661 33.197 46.930 35.140
  30.       49.810 35.870 52.200 36.210
  31.      00.31900E+0000.08805E+00
  32.      7505008
  33.      010004036
  34.      11.282  0.000020.557  0.014233.992  0.034543.440  0.0487
  35.        0.673  0.000  3.490  0.050 18.434  0.350 20.984  0.400
  36.       23.516  0.450 26.038  0.500 31.131  0.600 36.207  0.700
  37.       41.182  0.800 46.186  0.900
  38.       19.511 16.415 20.226 16.465 20.971 16.565 21.471 16.689
  39.       21.853 16.895 22.100 17.135 22.460 17.724 22.681 18.418
  40.       22.976 20.151 23.285 23.173 23.410 24.622 23.572 25.431
  41.       23.698 25.796 23.876 26.127 24.028 26.306 24.240 26.447
  42.       24.626 26.595 25.212 26.706 26.085 26.793 27.258 26.874
  43.       29.372 26.954 31.233 27.050 35.210 27.150 39.356 27.208
  44.       43.312 27.191 44.850 27.170 45.826 27.138 47.710 27.119
  45.       47.564 27.060 48.013 27.008 48.630 26.898 49.045 26.743
  46.       49.382 26.535 49.812 26.032 50.242 24.878 50.49  22.73
  47.       0.31950E+00 0.10130E+00
  48.      7505408
  49.      012004033
  50.       3.696  0.000015.5260 0.007325.9470 0.017233.611  0.0245
  51.        1.747  0.000  4.325  0.050 26.894  0.500 29.433  0.55
  52.       31.977  0.600 34.453  0.650 36.973  0.700 39.510  0.750
  53.       42.030  0.800 44.460  0.850 46.957  0.900 49.354  0.950
  54.       28.115  8.157 28.337  8.256 28.475  8.405 28.542  8.917
  55.       29.116 27.715 29.171 28.483 29.293 29.063 29.376 29.294
```

```
[illegible]
29.116 27.715 29.171 28.483 29.293 29.068 29.376 29.294
29.507 29.396 29.681 29.398 29.785 29.363 29.966 29.295
30.076 29.238 30.182 29.196 30.365 29.187 30.632 29.149
30.766 29.099 30.925 29.032 31.140 28.868 31.328 28.868
31.553 28.742 31.553 28.742 31.553 28.742 31.553 28.742
31.774 28.597 31.986 28.449 32.236 28.271 32.517 28.035
32.837 27.770 33.376 27.300 33.914 26.797 34.297 26.470
34.841 26.016 35.298 25.640 35.639 25.398 36.264 24.991
36.966 24.695 37.976 24.454 38.631 24.365 39.258 24.323
39.952 24.364 40.894 24.533 42.044 24.865 43.821 25.524
44.296 25.762 45.606 26.332 46.122 26.612 47.164 27.101
48.361 27.653 49.153 28.043 50.149 28.471 51.717 29.160
52.300 29.376
0.31950E+00 0.07419E+00
7506008
009006036
10.350  0.000 15.680  0.010 22.136  0.020 28.614  0.030
34.987  0.040 41.068  0.050
 4.906  0.000  9.819  0.100 14.884  0.200 19.888  0.300
24.988  0.400 30.110  0.500 35.128  0.600 40.194  0.700
45.130  0.800
17.056  9.277 17.056  9.277 17.537 34.067 17.688 34.616
17.921 34.618 18.093 34.494 18.356 34.075 18.536 33.963
18.700 33.785 19.082 33.125 19.475 32.270 19.873 31.332
20.690 29.438 21.359 28.045 22.006 27.039 22.645 26.271
23.170 25.905 23.852 25.668 24.346 25.654 24.965 25.793
25.618 26.169 26.414 26.738 27.728 27.950 28.968 29.247
30.398 30.840 32.122 32.822 33.429 34.158 34.723 35.334
35.791 36.148 36.895 36.874 38.209 37.556 39.591 38.141
41.330 38.663 42.636 38.964 44.234 39.243 44.905 39.318
0.31920E+00 0.11170E+000
7506208
008006041
 7.146  0.000 13.412  0.010 19.560  0.020 25.686  0.030
31.826  0.040 37.718  0.050
 1.668  0.000  6.713  0.100 16.683  0.300 21.711  0.400
26.762  0.500 31.811  0.600 36.842  0.700 41.861  0.800
16.642  8.048 17.104 34.761 17.248 35.298 17.410 35.237
17.568 35.054 17.737 34.878 17.949 34.359 18.256 34.104
18.598 33.416 18.863 33.016 19.200 32.225 19.396 31.772
19.822 30.760 20.226 29.695 20.814 28.498 21.412 27.416
21.847 26.762 22.411 26.168 23.324 25.546 24.053 25.303
24.630 25.234 25.790 25.379 27.406 25.846 28.443 26.363
29.484 27.043 30.722 28.138 32.089 29.659 33.051 30.926
34.077 32.348 35.133 33.849 36.064 35.084 37.263 36.508
37.927 37.119 38.718 37.758 39.341 38.162 39.888 38.476
40.699 38.810 41.443 39.075 42.384 39.310 43.136 39.444
44.072 39.538
0.31930E+00 0.10420E+000
7506308
006004025
14.524  0.000 20.869  0.020 27.228  0.040 33.357  0.060
 1.958  0.000 39.675  0.750 42.182  0.800 44.660  0.850
47.134  0.900 49.554  0.950
40.517 10.525 41.352 27.694 41.393 28.092 41.479 28.175
41.553 28.212 41.692 28.073 41.822 27.819 42.036 27.226
42.672 25.364 43.135 23.878 43.640 22.571 44.012 21.722
44.448 20.957 44.871 20.297 45.271 19.856 45.692 19.564
46.140 19.437 46.480 19.397 47.015 19.510 47.830 19.853
48.806 20.545 49.767 21.423 50.532 22.273 51.282 23.246
52.000 24.381
0.31880E+00 0.10920E+00
```

Quartz Reflection No plots #NOPLOT #965 11-19-75

```
V IV G LEVEL  21                    MAIN                DATE = 75323          13/31/20
                                                                  Modeled on QRTZPLOT
      DIMENSION TSA(100),ASA(100),ASB(100)                                          4
      DIMENSIONTIM(100),PRESS(100),TITLE1(10),TITLE2(10),P(100)                     5
      DIMENSION XX(50),YY(50),CUR(50),TT(50),X(100),Y(100)                          6
      DATA TITLE1/'PRES','SURE','  (K','B)  '/                                      7
      DATA TITLE2/'RAMP','ING ','ADJU','STED',' PRE',                               8
     1'SSUR','E (K','B)  '/                                                         9
      ELL=2.623                                                                    10
   25 FORMAT(3I3)                                                                  11
   26 FORMAT(08F7.3)                                                               12
   28 FORMAT(08F7.4)                                                               13
   27 FORMAT(2E12.5)                                                               14
      A=1.8900E-8                                                                  15
      B=10.700E-11                                                                 16
      ALFA=0.41                                                                    17
      ASA(1)=0.                                                                    18
      TSA(1)=0.                                                                    19
      ASB(1)=0.                                                                    20
      READ(5,77)II,JJ,KK                                                           21
      WRITE(6,88)II,JJ,KK                                                          22
   88 FORMAT(20X,'SHOT  ',I2,'-',I3,'-',I2,/)                                      23
   77 FORMAT(I2,I3,I2)                                                             24
      READ(5,25)NT,NCAL,NP                                                         25
      READ(5,28)(YY(I),CUR(I),I=1,NCAL)                                            26
      READ(5,26)(XX(I),TT(I),I=1,NT)                                               27
      READ(5,26)(X(I),Y(I),I=1,NP)                                                 28
      READ(5,27)TH,AR                                                              29
   20 FORMAT(1X,'GAUGE THICKNESS=',E11.4,5X,'AREA=',E11.4)                         30
      WRITE(6,20)TH,AR                                                             31
      PRINT 10,NT                                                                  32
   10 FORMAT(I5,12HTIMING MARKS)                                                   33
   21 FORMAT(1X,'DEFLECTION          TIME'/4X,'(MM)',9X,'(MICROSECS)')            34
      WRITE(6,21)                                                                  35
      PRINT 11,(XX(I),TT(I),I=1,NT)                                                36
   11 FORMAT(4X,F6.3,10X,F6.3)                                                     37
      PRINT 12,NCAL                                                                38
   12 FORMAT(I5,17HCALIBRATION MARKS)                                              39
   22 FORMAT(2X,'DEFLECTION',8X,'CURRENT'/5X,'(MM)',11X,'(AMPS)')                  40
      WRITE(6,22)                                                                  41
      NKAL=NCAL-1                                                                  42
      PRINT 13,(YY(I),CUR(I),I=1,NCAL)                                             43
      SUM=0.                                                                       44
C       FIND STANDARD DEVIATION OF CALIBRATION CURRENTS.                           45
C                                                                                  46
      DO 90 I=1,NKAL                                                               47
   90 SUM=SUM+YY(I+1)-YY(I)                                                        48
      SUM=SUM/NKAL                                                                 49
      SAM=0.                                                                       50
      DO 91 I=1,NKAL                                                               51
   91 SAM=SAM+(YY(I+1)-YY(I)-SUM)**2                                               52
      STP=100.*SQRT(SAM/(NKAL-1))/SUM                                              53
   23 FORMAT(1X,'STD DEVIATION=',E11.4,'PERCENT')                                  54
      WRITE(6,23) STP                                                              55
      WRITE(6,111)A,B,ALFA                                                         56
  111 FORMAT(1X,/5X,'A  =',E12.5,/5X,'B =',E12.5/2X,'ALFA =',E12.5/)                57
   13 FORMAT(4X,F6.3,10X,F9.5)                                                     58
   24 FORMAT(1X,//5X,'STRESS',8X,'TIME',8X,'X',13X,'Y',9X,                         59
     1'CURRENT'/5X,'(KBAR)',5X,'(MICROSECS)',3X,'(MM)',                            60
     28X,'(  MM  )',8X,'(AMPS)')                                                   61
```

```
I IV G LEVEL  21                    MAIN                    DATE = 75323          13/31/20

            WRITE(6,24)                                                              62
            CAY=TH/(AR*5.72E5)                                                       63
      C     DATA REDUCTION.                                                        64
            DO 30 I=1,NP                                                           65
      C    TIME REDUCTION.                                                         66
            DO 31 J=2,NT                                                           67
            K=J                                                                    68
      101   IF(XX(J)-X(I)) 31,34,34                                                69
      31    CONTINUE                                                               70
      34    TIM(I)=TT(K)+(TT(K)-TT(K-1))/(XX(K)-XX(K-1))*(X(I)-XX(K))              71
      C    CURRENT REDUCTION.                                                      72
            DO 41 J=2,NCAL                                                         73
            K=J                                                                    74
       201  IF(YY(J)-Y(I)) 41,44,44                                                75
         41 CONTINUE                                                               76
         44 TA=(CUR(K)-CUR(K-1))/(YY(K)-YY(K-1))                                   77
            AMP=CUR(K)+TA*(Y(I)-YY(K))                                             78
            IF(I-1) 49,50,49                                                       79
         50 AS=AMP                                                                 80
            TS=TIM(I)                                                              81
         49 AMP=AMP-AS                                                             82
            TIM(I)=TIM(I)-TS                                                       83
            AOB=-A/(2.*B)                                                          84
            PRESS(I)=AOB+(AOB**2+AMP*TH/(AR*5.72E5*B))**0.5                        85
            PRINT 51,PRESS(I),TIM(I),X(I),Y(I),AMP                                 86
            TSA(I+1)=TIM(I)                                                        87
            ASA(I+1)=AMP                                                           88
         51 FORMAT(3X,F8.3,5X,F8.3,3X,F8.3,5X,F8.3,5X,F8.5)                        89
         30 CONTINUE                                                               90
            AA=II                                                                  91
            BB=JJ                                                                  92
            CC=KK                                                                  93
            WRITE(6,62)                                                            94
         62 FORMAT(1X,//7X,'STRESS',6X,'TIME',2X,'CORRECTED CURRENT',              95
           +2X,'CURRENT',3X,'TIME/2.623')                                          96
            ENT=0.                                                                 97
      C     RAMPING CORECTION TO CURRENT.                                          98
            NPP=NP+1                                                               99
            DO 60 I=2,NPP                                                         100
            DTT=(TSA(I)-TSA(I-1))/2.                                              101
            TTT=ASA(I)-ALFA*ENT-ALFA*DTT*ASB(I-1)                                 102
            SCT=TSA(I)/ELL                                                        103
            ASB(I)=TTT/(1.+ALFA*DTT)                                              104
            ENT=ENT+(ASB(I)+ASB(I-1))*DTT                                         105
            PRESS(I)=AOB+(AOB**2+ASB(I)*TH/(AR*5.72E5*B))**.5                     106
            P(I-1)=PRESS(I)                                                       107
         60 PRINT 61,PRESS(I),TSA(I),ASB(I),ASA(I),SCT                            108
         61 FORMAT(5F12.5)                                                        109
            STOP                                                                  110
            END                                                                   111
```

Projectile Velocity Program

I have a program for velocity data reduction and one for tilt data reduction on the Conversational Basic system which we can access at Eastern Washington. The velocity program PRVEL1 now analyzes the data four ways: it computes velocities for each of the three intervals and averages them; it does straight-line least squares fit on the four X-T pairs assuming first that errors are in X, second that they are in T, and third that they are in both X and T. These all agree usually within a few tenths of a percent. But a least squares fit is probably more accurate than a simple averaging. Which fit to use depends on where we decide our errors are. Enter the data at line 50 and RUN.

Tilt Program

Since the 4 tilt pin times form an overdetermined set for the tilt value, a least squares fit is done (based on an analysis by L. Barker). Just say RUN and program will ask for data.

PRVEL1
4-14-77

```
*LIST
    2 REM          PROJECTILE VELOCITY PROGRAM
    4 REM PROGRAM FIRST COMPUTES VELOCITY PIN TIMES
    6 REM  PROGRAM COMPUTES VELOCITY IN FOUR WAYS
    8 REM   ENTER DATA AT LINE 50 IN FOLLOWING ORDER:
   10 REM (1) NUMBER OF TIMING MARKS; (2) NUMBER OF VELOCITY STEPS
   12 REM (3) TIMING MARK POSITION-TIME PAIRS
   14 REM (4) VELOCITY STEP POSITIONS
   16 REM (5) PIN SPACING VALUES
   23 DIM X(20),M(20)
   24 DIM D(50),I(50)
   25 DIM S(5)
   28 LET U2=0
   29 R1=0
   50 DATA 8,4
   52 DATA 0.656,0,4.158,10,11.252,30,14.814,40,25.554,70,29.135,80
   54 DATA 39.701,110,43.270,120
   56 DATA 0.464,14.263,26.191,40.242
   58 DATA 9.993,10.102,9.953
  100 READ N1,N2
  122 FOR I=1 TO N1
  124 READ X(I),M(I)
  126 NEXT I
  128 FOR I=1 TO N2
  130 READ D(I)
  132 NEXT I
  140 FOR I=1 TO N2-1
  142 READ S(I)
  144 NEXT I
  158 REM BEGIN CALCULATION
  160 FOR I=1 TO N2
  180 FOR J=2 TO N1
  198 REM FIND TIME VALUES
  200 LET K=J
  260 IF X(J)-D(I)<0 THEN 280
  270 GOTO 400
  280 NEXT J
  400 LET F2=(D(I)-X(K))/(X(K)-X(K-1))
  402 LET I(I)=M(K)+(M(K)-M(K-1))*F2
  408 IF I>1 THEN 420
  410 T6=I(I)
  420 I(I)=I(I)-T6
  430 NEXT I
  600 PRINT "PROJECTILE VELOCITY"
  610 REM     FIND VELOCITIES FOR THREE INTERVALS AND THEIR AVERAGE
  620 FOR I=1 TO N2-1
  640 LET U(I)=S(I)/(I(I+1)-I(I))
  660 PRINT "U(I)=",U(I)
  680 U2=U2+U(I)
  690 PRINT "TIME(I+1)=",I(I+1)
  700 NEXT I
  708 U8=U2/(N2-1)
  710 FOR I=1 TO N2-1
  715 R1=R1+(U(I)-U8)**2
  720 NEXT I
  730 F=SQR(R1/(N2-2))/6
  740 PRINT "AVERAGE PROJECTILE SPEED=";U8;" STD.DEV. =";F
  750 PRINT
  800 REM     USE LEAST SQUARES METHOD TO GET A BEST FIT VELOCITY
```

```
  800 REM     USE LEAST SQUARES METHOD TO GET A BEST FIT VELOCITY
  801 REM      'X(I)' HERE IS PIN POSITION
  802 X(1)=0
  803 X(2)=S(1)
  804 X(3)=S(2)+X(2)
  805 X(4)=S(3)+X(3)
  810 D9=(X(4)-X(1))/3
  820 C1=X(1)*T(1)+X(2)*T(2)+X(3)*T(3)+X(4)*T(4)
  830 C2=X(1)+X(2)+X(3)+X(4)
  840 C3=T(1)+T(2)+T(3)+T(4)
  850 C4=T(1)**2+T(2)**2+T(3)**2+T(4)**2
  860 C5=X(1)**2+X(2)**2+X(3)**2+X(4)**2
  870 REM     LEAST SQUARES ASSUMING ERRORS IN POSITION
  871 REM     EQUATION IS X=V1*T+X0
  880 V1=(C1-.25*C2*C3)/(C4-.25*C3**2)
  890 X0=.25*(C2-V1*C3)
  900 FOR I=1 TO 4
  910 D(I)=X(I)-V1*T(I)-X0
  920 E(I)=D(I)**2
  930 NEXT I
  938 R1=(E(1)+E(2)+E(3)+E(4))/3
  940 S9=SQR(R1)
  950 F=100*S9/D9
  960 PRINT "VELOCITY","    X0    ","% STD. DEV. IN X-INTERVALS"
  970 PRINT V1,X0,F
  980 PRINT "ABSOLUTE DEVIATIONS IN X(I)"
  990 PRINT D(1),D(2),D(3),D(4)
 1008 PRINT
 1010 REM      LEAST SQUARES ASSUMING ERRORS IN TIME
 1012 REM      EQUATION IS T=(1/V2)*X-(X0/V2)
 1020 V2=(C5-C.25*C2**2)/(C1-C.25*C2*C3)
 1030 X0=-V2*(C5*C3-C1*C2)/(4*C5-C2**2)
 1040 FOR I=1 TO 4
 1050 F(I)=T(I)-X(I)/V2+X0/V2
 1060 G(I)=F(I)**2
 1070 NEXT I
 1080 R1=(G(1)+G(2)+G(3)+G(4))/3
 1088 T9=(T(4)-T(1))/3
 1090 S9=SQR(R1)
 1100 F=100*S9/T9
 1110 PRINT "VELOCITY","     X0    ","% STD.DEV. IN T-INTERVALS"
 1120 PRINT V2,X0,F
 1130 PRINT "ABSOLUTE DEVIATIONS IN T(I)"
 1140 PRINT F(1),F(2),F(3),F(4)
 1150 PRINT
 1200 REM      LEAST SQUARES FIT ; ERRORS ON BOTH X AND T
 1220 A7=2*C1/(C4-C5)
 1230 T7=0.5*ATN(A7)
 1240 A5=SIN(T7)
 1250 A6=COS(T7)
 1260 V3=A5/A6
 1270 P7=A5*C3/4-A6*C2/4
 1280 X0=-P7/A6
 1290 PRINT "VELOCITY","     X0    ","   ERRORS ON BOTH X AND T"
 1300 PRINT V3,X0
*RYE
/LOGOFF
TC F400 LOGOFF AT 1903 ON 04/14/77, FOR ISN 4627.
TC F421 CPU TIME USED:  000006.7879 SECONDS.F
```

```
 1990 PRINT
*LIST 1990
 1990 PRINT "VELOCITY","    XO    "
*1990 PRINT "VELOCITY","    XO    "," , ERRORS ON BOTH X AND T"
*PRINT
?RUN
PROJECTILE VELOCITY
U(I)=              .255965 mm/μsec
TIME(I+1)=         39.0014 μsec
U(I)=              .303129
TIME(I+1)=         72.3971
U(I)=              .250472
TIME(I+1)=         112.064
AVERAGE PROJECTILE SPEED=  .263855   % STD.DEV. = 10.7267

VELOCITY            XO          % STD. DEV. IN X-INTERVALS
 .270887        -.102047          4.61728
ABSOLUTE DEVIATIONS IN X(I)
 .102047        -.479913           .59457          -.216679

VELOCITY            XO          % STD.DEV. IN T-INTERVALS
 .271234        -.121428          4.56588
ABSOLUTE DEVIATIANS IN T(I)
-.447686          1.74782        -2.17103           .87078

VELOCITY            XO                ERRORS ON BOTH X AND T
 .263715        -.365943E-01
*SAVE PRVEL1
OVERWRITE PREVIOUS FILE. (YES,NO)?.YES
READY
```

PRVEL7

75-054

4-14-74

```
   50 DATA 8,4
   52 DATA 1.970,0,4.366,10,14.178,50,16.660,60,29.170,110,31.672,120
   54 DATA 44.075,170,46.530,180
   56 DATA 2.315,16.320,30.35,44.4
   58 DATA 9.987,10.033,9.921
```

Data Lines For 77-019

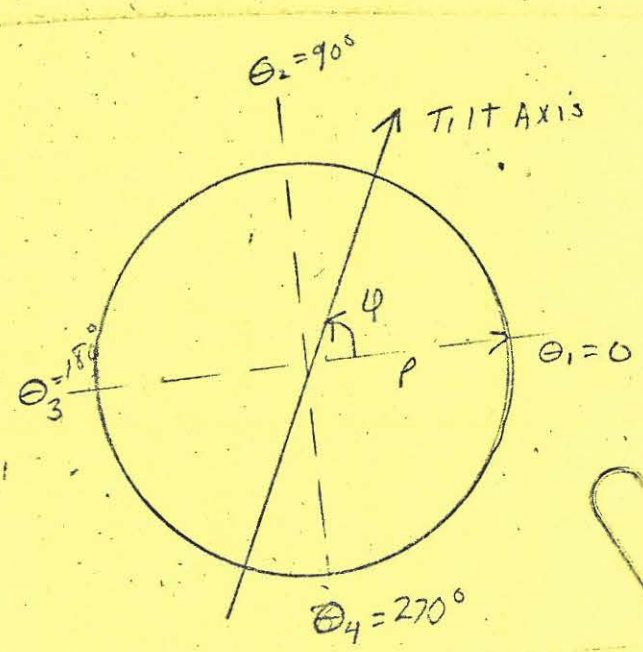
Enter These, Then RUN

```
*LIST
   10 DIM T(4),H(4),A(4,4),B(4,4),D(4,4)
   20 PRINT "ENTER CLOSURE TIME OF PINS"
   30 INPUT T(1),T(2),T(3),T(4)
   40 LET PI=3.1415927
   42 LET H(1)=0
   44 LET H(2)=PI/2
   46 LET H(3)=PI
   48 LET H(4)=3*PI/2
   60 PRINT "ENTER RADIUS OF PIN LOCATION"
   70 INPUT R8
   80 PRINT "ENTER PROJECTILE SPEED"
   90 INPUT U8
  100 LET A=0
  110 LET B=0
  120 LET C=0
  130 LET D=0
  140 E=0
  150 FOR I=1 TO 4
  160 FOR J=1 TO 4
  170 IF I=J THEN 260
  180 LET A(I,J)=SIN(H(J))-SIN(H(I))
  190 LET B(I,J)=COS(H(J))-COS(H(I))
  200 LET D(I,J)=T(J)-T(I)
  210 LET A=A+D(I,J)*A(I,J)
  220 LET B=B+D(I,J)*B(I,J)
  230 LET C=C+A(I,J)**2
  240 LET D=D+B(I,J)**2
  250 LET E=E+A(I,J)*B(I,J)
  260 NEXT J
  270 NEXT I
  280 LET P8=ATN(-B*C/(A*D))
  290 LET A8=U8/R8*SQR(A**2*D**2+B**2*C**2)/(C*D)
  300 PRINT "COORDINATE ANGLE OF THE TILT AXIS=",P8
  310 PRINT "TILT ANGLE IN RADIANS=",A8
  320 STOP
  330 END
 *RUN
 TRUN
ENTER CLOSURE TIME OF PINS
?0.0,.146,.253,.107
ENTER RADIUS OF PIN LOCATION
?44.4
ENTER PROJECTILE SPEED
?.200
COORDINATE ANGLE OF THE TILT AXIS=          1.41785
TILT ANGLE IN RADIANS=          .576549E-03
 *RUN
ENTER CLOSURE TIME OF PINS
?0.0,.146,-.75,.107
ENTER RADIUS OF PIN LOCATION
?44.4
ENTER PROJECTILE SPEED
?.200
COORDINATE ANGLE OF THE TILT AXIS=          -1.51884
TILT ANGLE IN RADIANS=          .169147E-02
 *
/LOGOFF
%C E420 LOGOFF AT 2116 ON 09/08/76, FOR TSN 0298.
%C E421 CPU TIME USED:  000001.5905 SECONDS.
```

TILT 1

5-13-76

EMSC



76-043

TILT 1

0.58 mrad

$d = 2\varepsilon = 0.2(.75\,\mu m) = 0.38\,mm = 0.015''$

1.69 mrad