DIRMAP : A FORTRAN PROGRAM TO SIMULATE BEAM-BEAM LIKE
INTERACTIONS WITH A TUNE MODULATED DIRECT MAP.
A SHORT PRIMER.

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1. INTRODUCTION

This short note is intended as a quick manual for the use of a small group of Fortran programs which make possible a simulation of some peculiar aspects of storage rings with negative beams as the CERN Antiproton Accumulator [1], [2].

The betatron motion of the particle in the ring is described in a rudimentary fashion as a harmonic oscillator:

$$x''(\theta) + \nu_x^2 x(\theta) = 0$$
$$y''(\theta) + \nu_y^2 y(\theta) = 0 \qquad (1)$$

tune modulation and periodic kicks (from beam-beam like interactions) are introduced in eq. (1):

$$x''(\theta) + \nu_{ox}^2(1-\lambda\cos\nu_s\theta)x(\theta) = \xi x \Phi(x,y)\Sigma_n \delta(\theta-n2\pi) \qquad (2)$$

a Direct Map is deduced from equation (2) for both planes (x-p_x, y-p_y); with the same notation as in reference [2]

$$x_{n+1}(n+1) = [D_1 x_n(n) + D_2(x'_n(n)+(2/\nu_s)\xi x_n(n)\Phi(n)]/D$$

$$\qquad (3)$$

$$x'_{n+1}(n+1) = [D_3 x_n(n) + D_4(x'_n(n)+(2/\nu_s)\xi x_n(n)\Phi(n)]/D$$

The Direct Map described in equation (3) has been translated in a Fortran language code called DIRMAP (a copy of DIRMAP can be found at the end of this note) .

2. OPERATIONS

Two different ion distribution can be chosen:

if the choice is the cylindrical distribution ($\sigma_x=\sigma_y$) then
          lines 79/84 must be active
          lines 87.1/96 must be non-active
if the choice is the elliptical distribution (Bassetti- Erskine potent.)
($\sigma_x>\sigma_y$) then :
          lines 79/84 must be non-active
          lines 87.1/96 must be active

Random kicks can be activated at lines 100/110

Lines 218/232 are used to calculate the maxima and the minima of J_x and J_y (actions) in every group of 100 sequential data (turns or map iterations). Extrapolation of this maxima and minima can be done by means of a separate code (ERT) which uses extrapolation algorithms .

The input of the code are few parameters in lines 264/274 with the order defined in line 39 .

The output of the code are two sequential files :

MAPDAT : to be used with PHSPP to obtain Phase Space plot of the map.
     to be used with LOLYAP to obtains the pictures of the signature
     of motion (stable or chaotic) [2].
     In this second case two different runs with DIRMAP must be ini
     tiated in order to obtain two different output files
     (MAPDAT2 and MAPDAT3) .
MMDAT : to be used with ERT to extrapolate the maxima and the minima of
J_x and J_y .

PHSPP and LOLYAP are two standard plot subroutines written with the GD3 package which in order to gain in flexibility can be used separately from DIRMAP. the input is always the sequential output MAPDAT (or MAPDAT2 + MAPDAT3).

The ouptut can be seen at CERN with the H TOOL TV command (a picture library - with the H LIBALLO comm. - must be created before running PHSPP or LOLYAP). To obtain an output on the Versatec plotter , remove the star in the last line (//* EXEC GD3VT) .

The complete procedure for the phase space plot (under WILBUR) are the following :
 a. SCR MAPDAT
  SCR MMDAT
 b. change parameters or kind of potential in DIRMAP
 c. RUN DIRMAP

once the MAPDAT file is created ...

d. create a library with the 'H LIBALLO' command
e. RUN PHSPP

after the run

f. H TOOL TV to see the pictures on the screen .

pictures can be deleted with SCR PLIB#PICT003 (to delete picture # 3);
the complete library can be scratched with SCR PLIB .

    The complete procedure for the chaos signature plots (under WILBUR) is
the following :

a. SCR MAPDAT
   SCR MMDAT
b. change parameters or kind of potential in DIRMAP ;
     change in line 59 to obtain   X=XO + 0.1E-05 (or 0.1E-04)
c. change the name of the output file to MAPDAT2
d. RUN DIRMAP (output MAPDAT2)
e. change the name of the output file to MAPDAT3
f. change in line 59 to obtain x=xo
g. RUN DIRMAP (output MAPDAT3)

after the two output files are created ...

h. RUN LOLYAP (a picture library must be created before)
i. see the picture with the 'H TOOL TV ' command .

    In order to obtain picture of instability (resonances) over a finite
range of horizontal tune , a different version of DIRMAP is available; the
new version is NURALL. The most important change is a loop initiated at
lines 49. Essentially NURALL executes a complete DIRMAP run (up to 5000
map iteration) for each step in the chosen range .
 The tune step must be defined at line 48 (DNU= 0.2E-02).
 The output file is RESPDAT and the input parameters are introduced as in
DIRMAP .
 Because of the unpredictability of number and strength of resonances in
the chosen range, in order to obtain pictures like fig.7 two or more steps
must be done.

    The complete procedure is the following:

a. SCR RESPDAT
b. RUN NURALL
c. after the run , see how many steps of the range have been done ;
d. modify NUOX at line 296; the new value must be equal to the value of
the last completed iteration;
e. RUN NURALL   (without scratching RESPDAT !)

repeat c,d,e until the complete range is covered ;

f. RUN READ to read the RESPDAT file ;
g. attach the READ output to line 76.01 of PRES (Picture of RESonances);
h. RUN PRES (a picture library must be created before).
i. the picture can be seen with the 'H TOOL TV' command .

The synoptic table of the programs is the following :

```
DIRMAP                 PHSPP, LOLYAP, ERT
DIRSEX

NURALL        READ                              PRES
NURSEX
```

DIRSEX and NURSEX are different versions of DIRMAP and NURALL in which only sextupolar terms are used in the kick

REFERENCES

[1]   E. Jones et al.   CERN/PS/Note 85-15   (AA),   1985; Proc.   Part. Acc. Conf. Vancouver, 1985, IEEE Trans. Nucl. Sci. NS-32 .

[2]   A. Dainelli CERN-PS/AA/Note 86-13

```
//DLIDIRM JOB DLI$PZ,TIME=(1,58)
// EXEC JFORTCG,LLB2='CR.PUB.PRO.GENLIB'
/*NOTIFY DLI$PZ
//C.SYSIN DD *
C
C
C
C
C ********!***********************************************
C *******!*********                                             5.9.85
C ******!*******
C *****!*****           D I R M A P        CRAY :    REAL*8 (*16), E (Q), FUN (QFUN)
C ****!****
C ***!****
C **!***
C *!***
C !****!*****************************************************************
C *****!*****
C ****!****
C ***!****
C NN       total number of turns (map iterations)
C CSI      coupling constant for the interaction
C SIGMA    variance of the transversal beam distribution
C NUOX     horizontal betatron tune
C NUOY     vertical betatron tune
C AM       betatron tune modulation amplitude
C NUS      betatron tune modulation frequency
C XO,PXO   initial coordinates in the horizontal phase space
C YO,PYO   initial coordinates in the vertical phase space
C
C
C
C
C ********************************************************************************************
C
      IMPLICIT REAL*16 (A-H,O-Z)
      REAL*16 NUOX,NUOY,NUS,NUX,NUY,NN
      REAL*16 MX,MDX,MY,MDY,NX,NDX,NY,NDY
      REAL*16 MXP,MDXP,MYP,MDYP,NXP,NDXP,NYP,NDYP
      REAL*16 MAXX,MINX,MAXY,MINY
      REAL*16 JX,JY,JM
      COMPLEX CWERF,ZZ,ZW,ZN,ZWN,CEW
      EXTERNAL CWERF
      READ(5,100) NUOX,NUOY,NUS,AM,CSI,SIGMA,XO,PXO,YO,PYO,NN
      AM=0.0
C     WRITE(30,100) NUOX,NUOY,NUS,AM,CSI,SIGMA,XO,PXO,YO,PYO,NN
      WRITE(10,100) NUOX,NUOY,NUS,AM,CSI,SIGMA,XO,PXO,YO,PYO,NN
C ****!*******************************************************************************
      JM=0.100000E+03
      PI=4.00Q+00*QATAN(1.0Q+00)
      NUX=2.*NUOX/NUS
      NUY=2.*NUOY/NUS
      QQX=((NUX**2.)/2.)*AM
      QQY=((NUY**2.)/2.)*AM
      QX=QQX/(NUX**2.)
      QY=QQY/(NUY**2.)
C ****!*******************************************************************************
      CX11=-QX/(4.*(NUX+1.))
      CX12=QX/(4.*(NUX-1.))
      CY11=-QY/(4.*(NUY+1.))
      CY12=QY/(4.*(NUY-1.))
C ****!*******************************************************************************
      N=0
      X=XO
      PX=PXO
      Y=YO
```

```fortran
62.         PY=PY0
63.  C
64.         SIGMAY=SIGMA
65.         SIGMA=4.0Q+00*SIGMA
65.15       SIGMAX=SIGMAX**2-SIGMAY**2
65.2        DSIGMA=SIGMAX**2-SIGMAY**2
66.  C following statem. must be activeted only with bassetti-erskine pot.
            CSI=CSI*(QSQRT(PI)/2.0Q+00)*(SIGMA**2/DSIGMA)
67.  C
68.         GO TO 2
69.  C ****!*********************************************************
          1 N=N+1
70.  C
71.  C
72.  C                           ion-beam coupling constant on/off
73.  C
74.  C      CSI=0.000D+00          decentralization    on/off
75.  C
76.  C      XC=0.400D+01
            X=X-XC
77.
78.  C                 cylindrical distribution ; SIGMAX=SIGMAY
79.  C
80.  C      RQ=X**2+Y**2
81.  C
81.5 C      RN=RQ/(2.0Q+00*SIGMA**2)
82.  C      PHI=(1.0Q+00-QEXP(-RN))/RN
83.  C      EEX=X*PHI
84.  C      EEY=Y*PHI
86.  C                 elliptical distribution ;  SIGMAX > SIGMAY
86.1 C                    ( Bassetti-Erskine potential )
87.  C
87.1        IF(X.GT.174.0.OR.Y.GT.174.0) GO TO 599
87.2        AMZZ=X**2+Y**2
87.3        IF(AMZZ.GT.174) GO TO 599
89.         ZZ=CMPLX(X,Y)
90.         ZN=Z/QSQRT(2.0Q+00*DSIGMA)
91.         ZW=CMPLX(X*(SIGMAY/SIGMAX),Y*(SIGMAX/SIGMAY))
92.         ZWN=ZW/QSQRT(2.0Q+00*DSIGMA)
93.         CEW=CWERF(ZN)-
94.        $QEXP(.05Q+00*((Y/SIGMAY)**2-(X/SIGMAX)**2))*CWERF(ZWN)
95.         EEX=AIMAG(CEW)*QSQRT(2.0Q+00*DSIGMA)
96.         EEY=REAL(CEW)*QSQRT(2.0Q+00*DSIGMA)
97.  C
98.  C
99.  C                                            random kick
100. C      PP=RANF()
101. C      IF(PP.LT.0.3) THEN
102. C              AA=(1.0+3.*RANF())
103. C              AA=(1.0*RANF())
104. C              BB=2*(0.5-RANF())
105. C          ELSE
106. C              BB=0.0
107. C      ENDIF
108. C      AA=(1.0+3.0*BB)
109. C      AA=1.0
110. C      CSI=CSI*AA
111. C
112. ****!*********************************************************
113. C
114. C
115. C
116.       2 Z=PI*NUS*N
117.         ZX=Z-(QX/2.)*QSIN(2.*Z)
```

```
118.        ZY=Z-(QY/2.)*QSIN(2.*Z)
119. C     **************************************************************************
120.        CEX=QCOS(NUX*Z)+
121.       % CX11*QCOS((NUX+2.)*Z)+CX12*QCOS((NUX-2.)*Z)
122. C
123.        CEDX=-(NUX*QSIN(NUX*Z)+
124.       % CX11*(NUX+2.)*QSIN((NUX+2.)*Z)+CX12*(NUX-2.)*QSIN((NUX-2.)*Z))
125. C
126.        SEX=QSIN(NUX*Z)+
127.       % CX11*QSIN((NUX+2.)*Z)+CX12*QSIN((NUX-2.)*Z)
128. C
129.        SEDX=NUX*QCOS(NUX*Z)+
130.       % CX11*(NUX+2.)*QCOS((NUX+2.)*Z)+CX12*(NUX-2.)*QCOS((NUX-2.)*Z)
131. C     **************************************************************************
132.        CEY=QCOS(NUY*Z)+
133.       % CY11*QCOS((NUY+2.)*Z)+CY12*QCOS((NUY-2.)*Z)
134. C
135.        CEDY=-(NUY*QSIN(NUY*Z)+
136.       % CY11*(NUY+2.)*QSIN((NUY+2.)*Z)+CY12*(NUY-2.)*QSIN((NUY-2.)*Z))
137. C
138.        SEY=QSIN(NUY*Z)+
139.       % CY11*QSIN((NUY+2.)*Z)+CY12*QSIN((NUY-2.)*Z)
140. C
141.        SEDY=NUY*QCOS(NUY*Z)+
142.       % CY11*(NUY+2.)*QCOS((NUY+2.)*Z)+CY12*(NUY-2.)*QCOS((NUY-2.)*Z)
143. C     **************************************************************************
144. C
145. C
146.        ALFAX=(NUX**2-QQX*2.*QCOS(2.*ZX))
147.        ALFAY=(NUY**2-QQY*2.*QCOS(2.*ZY))
148.        ZDX=(1.-QX*QCOS(2.*Z))
149.        ZDY=(1.-QY*QCOS(2.*Z))
150.        BETAX=-((ALFAX**(-1.25))/4.)*QQX*4.*QSIN(2.*ZX)*ZDX
151.        BETAY=-((ALFAY**(-1.25))/4.)*QQY*4.*QSIN(2.*ZY)*ZDY
152.        T=0.25
153.        BBX=ALFAX**(T)
154.        BBY=ALFAY**(T)
155.        BX=1.0/BBX
156.        BY=1.0/BBY
157.        MX=BX*CEX
158.        MDX=(BETAX*CEX+BX*CEDX*ZDX)
159.        NX=BX*SEX
160.        NDX=(BETAX*SEX+BX*SEDX*ZDX)
161. C
162.        MY=BY*CEY
163.        MDY=(BETAY*CEY+BY*CEDY*ZDY)
164.        NY=BY*SEY
165.        NDY=(BETAY*SEY+BY*SEDY*ZDY)
166. C
167.        IF(N.EQ.0) GO TO 3
168. C
169.        DELX=MDXP*NXP-MXP*NDXP
170.        DELY=MDYP*NYP-MYP*NDYP
171.        D1X=MDXP*NX-MX*NDXP
172.        D1Y=MDYP*NY-MY*NDYP
173.        D2X=MX*NXP-MXP*NX
174.        D2Y=MY*NYP-MYP*NY
175.        D3X=MDXP*NDX-MDX*NDXP
176.        D3Y=MDYP*NDY-MDY*NDYP
177.        D4X=MDX*NXP-MXP*NDX
178.        D4Y=MDY*NYP-MYP*NDY
179. C
```

```fortran
180.   C     *************************************************************
181.   C        X=(XP*D1X+(PXP-XP*CSP*2./NUS)*D2X)/DELX
182.   C        PX=(XP*D3X+(PXP-XP*CSP*2./NUS)*D4X)/DELX
183.   C        Y=(YP*D1Y+(PYP-YP*CSP*2./NUS)*D2Y)/DELY
184.   C        PY=(YP*D3Y+(PYP-YP*CSP*2./NUS)*D4Y)/DELY
185.   C
186.   C        X=(XP*D1X+(PXP-XP*CSP)*(2./NUS)*D2X)/DELX
187.   C        PX=(XP*D3X+(PXP-XP*CSP)*(2./NUS)*D4X)*NUS/(2.*DELX )
188.   C        Y=(YP*D1Y+(PYP-YP*CSP)*(2./NUS)*D2Y)/DELY
189.   C        PY=(YP*D3Y+(PYP-YP*CSP)*(2./NUS)*D4Y)*NUS/(2.*DELY)
190.   C
191.           X=(XP*D1X+(PXP-CSI*EEX)*(2./NUS)*D2X)/DELX
192.           PX=(XP*D3X+(PXP-CSI*EEX)*(2./NUS)*D4X)*NUS/(2.*DELX )
193.           Y=(YP*D1Y+(PYP-CSI*EEY)*(2./NUS)*D2Y)/DELY
194.           PY=(YP*D3Y+(PYP-CSI*EEY)*(2./NUS)*D4Y)*NUS/(2.*DELY)
195.   C
196.         3 IF(X.GT.300.0.OR.PX.GT.300.0) GO TO 599
196.1          EX=QSQRT((PX/NUOX)**2+X**2)
197.           EY=QSQRT((PY/NUOY)**2+Y**2)
198.           WRITE(6,202) EX,EY
199.   C
200.   C     *************************************************************
201.   C
202.           XN=X*QSQRT(NUOX/2.)
203.           PXN=-PX/(QSQRT(2.*NUOX))
204.           JX=XN**2+PXN**2
205.           YN=Y*QSQRT(NUOY/2.)
206.           PYN=-PY/(QSQRT(2.*NUOY))
207.           JY=YN**2+PYN**2
208.   C
209.           EE=(EX+EY)/2.
210.           IF(JX.GT.JM) GO TO 599
211.   C
212.   C     *****!*******************************************************
213.   C
214.           WRITE(20,202) JX,JY
215.           WRITE(6,202) JX,JY
216.           WRITE(10,204) X,PX,Y,PY,JX,JY,N
217.   C
218.           AN=N/100.
219.           AIN=AINT(AN)
220.           IF(AIN.EQ.AN) THEN
221.                          WRITE(30,3000) MAXX,MINX,MAXY,MINY
222.                          WRITE(6,3000) MAXX,MINX,MAXY,MINY
223.                          MAXX=JX
224.                          MINX=JX
225.                          MAXY=JY
226.                          MINY=JY
227.                    ELSE
228.                          IF(JX.GE.MAXX) MAXX=JX
229.                          IF(JX.LE.MINX) MINX=JX
230.                          IF(JY.GE.MAXY) MAXY=JY
231.                          IF(JY.LE.MINY) MINY=JY
232.                   ENDIF
233.   C     *****!*******************************************************
234.   C
235.           XP=X
236.           PXP=PX
237.           YP=Y
238.           PYP=PY
239.   C
240.           MXP=MX
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```
  241.       MDXP=MDX
  242.       NXP=NX
  243.       NDXP=NDX
  244.       MYP=MY
  245.       MDYP=MDY
  246.       NYP=NY
  247.       NDYP=NDY
  248. C ****!*******2*******3*******4*******5*******6*******7**
  249.       IF(N.EQ.NN) GO TO 600
  250.       GO TO 1
  251. C ****!*******2*******3*******4*******5*******6*******7**
  252.  100  FORMAT(D13.7)
  253.  202  FORMAT(1X,2(D13.7))
  254.  204  FORMAT(1X,6(D13.7),I8)
  255. C
  256. C ****!*******2*******3*******4*******5*******6*******7**
  257. 3000  FORMAT(1X,4(D13.7))
  258.  599  WRITE(30,3000) MAXX,MINX,MAXY,MINY
  259.       WRITE(6,3000) MAXX,MINX,MAXY,MINY
  260.  600  STOP
  261.       END
  262. /*
  263. //G.SYSIN   DD    *
  264. 0.2336000D+01
  265. 0.2256500D+01
  266. 0.1600000D-03
  267. 0.0000000D+00
  268. 0.2000000D-01
  269. 0.1000000D+01
  270. 0.0400000D+02
  271. 0.0000000D+00
  272. 0.0300000D+02
  273. 0.0000000D+00
  274. 0.5000000D+04
  275. /*
  276. //G.FT30F001  DD  DSN=PZ.DLI.MMDAT,UNIT=SYSDA,DISP=(NEW,CATLG),
  277. //    SPACE=(TRK,(2,1),RLSE)
  278. //G.FT10F001  DD  DSN=PZ.DLI.MAPDAT,UNIT=SYSDA,DISP=(NEW,CATLG),
  279. //    SPACE=(CYL,(2,1),RLSE)
```

```
  1.  //DLIPHSP JOB DLI$PZ,TIME=(1,58)
  2.  // EXEC JFORTCG,GRGN=2000K
  3.  /*NOTIFY DLI$PZ
  4.  //C.SYSIN DD *
  5.  C
  6.  C *****************************************************************
  7.  C ****!************************************************************
  8.  C
  9.  C
 10.  C          P H S P P        ( -10.0 < x < +10.0 )
 11.  C
 12.  C *****************************************************************
 13.  C ****!************************************************************
 14.  C ****!************************************************************
 15.        DOUBLE PRECISION NUOX,NUOY,NUS,AM,CSI,SIGMA,XO,PXO,YO,PYO,NN
 16.        DOUBLE PRECISION DX,DPX,DY,DPY,DJX,DJY
 17.        REAL X1(5000),Y1(5000),X2(5000),Y2(5000),Y3(5000),X4(5000),
 18.       $Y4(5000)
 19.        INTEGER N,K
 20.        DIMENSION XX(3),YY(3)
 21.  C ****!************************************************************
 22.        CALL TVBGN(11)
 23.  C ****!************************************************************
 24.        READ(20,100) NUOX,NUOY,NUS,AM,CSI,SIGMA,XO,PXO,YO,PYO,NN
 25.  C
 26.        K=0
 27.      1 K=K+1
 28.        READ(20,90,END=11) DX,DPX,DY,DPY,DJX,DJY,N
 29.        X1(K)=FLOAT(N)/10.
 30.        V1(K)=SNGL(DJX)
 31.        X2(K)=SNGL(DX)
 32.        Y2(K)=SNGL(DPX)
 33.        Y3(K)=SNGL(DJY)
 34.        X4(K)=SNGL(DY)
 35.        Y4(K)=SNGL(DPY)
 36.        GOTO 1
 37.     11 N=K-1
 38.  C
 39.        CALL TVRNG(4HUSER,0.0,0.0,1000.0,100.0)
 40.        CALL TVAX(1HX,5HTURNS,5)
 41.        CALL TVORNT(5HANGLE,90.0)
 42.  C
 43.        CALL TVAX(1HY,12HJX INVARIANT,12)
 44.        CALL TVORNT(5HANGLE,0.0)
 45.  C
 46.  C
 47.        XX(1)=0.0
 48.        XX(2)=1000.0
 49.        XX(3)=1000.0
 50.        YY(1)=100.0
 51.        YY(2)=100.0
 52.        YY(3)=0.0
 53.        CALL TVDRAW(XX,YY,3)
 54.  C
 55.        FLGTYP=.TRUE.
 56.        CALL TVSET(8HHARDCHAR)
 57.        CALL TVMODE(4HFULL)
 58.  C
 59.        CALL TVTEXT(480.0,950.0,8H3*NUOX=7,8,1)
 60.        CALL TVTEXT(0.0,-5.0,5HNUOX=,5,1)
 61.        CALL TVTEXT(0.0,-8.0,5HNUOY=,5,1)
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  62.       CALL TVTEXT(745.0,-5.0,3HAM=,3,1)
  63.       CALL TVTEXT(728.0,-8.0,4HNUS=,4,1)
  64.       CALL TVTEXT(300.0,-8.0,4HCSI=,4,1)
  65.       CALL TVTEXT(680.,95.,12HHOR.SCALE*10,12,1)
  66.       CALL TVNUMB(100.0,-5.0,NUOX,6H(F8.6),8)
  67.       CALL TVNUMB(100.0,-8.0,NUOY,6H(F8.6),8)
  68.       CALL TVNUMB(822.0,-5.0,AM,6H(E9.3),9)
  69.       CALL TVNUMB(822.0,-8.0,NUS,6H(E9.3),9)
  70.       CALL TVNUMB(390.0,-8.0,CSI,6H(E9.3),9)
  71.       CALL TVNUMB(816.960,ISCALE,4H(I1),1)
  72.       CALL TVGRPH(X1,Y1,-N)
  73.       CALL TVTEXA(0.0,0.0,2HJX,2,1)
  74. C *********************************************************
  75. C      CALL TVNEXT
  76. C *********************************************************
  77. C
  78.
  79.       CALL TVRNG(4HUSER,-10.0,-10.0,10.0,10.0)
  80.       CALL TVAX(1HX,1HX,1)
  81.       CALL TVAX(1HY,2HPX,2)
  82.       XX(1)=-10.0
  83.       XX(2)=10.0
  84.       XX(3)=10.0
  85.       YY(1)=10.0
  86.       YY(2)=10.0
  87.       YY(3)=-10.0
  88.       CALL TVDRAW(XX,YY,3)
  89.
  90. C      CALL TVMODE(4HFULL)
  91.       FLGTYP=.TRUE.
  92.       CALL TVSET(8HHARDCHAR)
  93.       CALL TVTEXT(16.0,27.0,8H3*NUOX=7,8,1)
  94.       CALL TVTEXT(-10.0,-11.0,5HNUOX=,5,1)
  95.       CALL TVTEXT(-10.0,-11.7,5HNUOY=,5,1)
  96.       CALL TVTEXT(5.0,-11.0,3HAM=,3,1)
  97.       CALL TVTEXT(5.0,-11.7,4HNUS=,4,1)
  98.       CALL TVTEXT(-4.0,-11.7,4HCSI=,4,1)
  99.       CALL TVNUMB(-8.0,-11.0,NUOX,6H(F8.6),8)
 100.       CALL TVNUMB(-8.0,-11.7,NUOY,6H(F8.6),8)
 101.       CALL TVNUMB(7.0,-11.0,AM,6H(E9.3),9)
 102.       CALL TVNUMB(7.0,-11.7,NUS,6H(E9.3),9)
 103.       CALL TVNUMB(-2.0,-11.7,CSI,6H(E9.3),9)
 104.       CALL TVPLOT(X2,Y2,N)
 105. C *********************************************************
 106. C
 107. C      CALL TVNEXT
 108. C *********************************************************
 109. C
 110.
 111.       CALL TVRNG(4HUSER,0.0,0.0,1000.0,100.0)
 112.       CALL TVAX(1HX,5HTURNS,5)
 113.       CALL TVAX(1HX,5HTURNS,5)
 114.       CALL TVORNT(5HANGLE,90.0)
 115.       CALL TVAX(1HY,12HJY INVARIANT,12)
 116.       CALL TVORNT(5HANGLE,0.0)
 117. C
 118.       XX(1)=0.0
 119.       XX(2)=1000.0
 120.       XX(3)=1000.0
 121.       YY(1)=100.0
 122.       YY(2)=100.0
 123.       YY(3)=0.0
```

```
124.        CALL  TVDRAW(XX,YY,3)
125.   C
126.        FLGTYP=.TRUE.
127.        CALL  TVSET(8HHARDCHAR)
128.        CALL  TVMODE(4HFULL)
129.   C
130.        CALL  TVTEXT(480.0,950.0,8H3*NUOX=7,8,1)
131.        CALL  TVTEXT(0.0,-5.0,5HNUOX=,5,1)
132.        CALL  TVTEXT(0.0,-8.0,5HNUOY=,5,1)
133.        CALL  TVTEXT(745.0,-5.0,3HAM=,3,1)
134.        CALL  TVTEXT(728.0,-8.0,4HNUS=,4,1)
135.        CALL  TVTEXT(300.0,-8.0,4HCSI=,4,1)
136.        CALL  TVTEXT(680.,95.,12HHOR.SCALE*10,12,1)
137.        CALL  TVNUMB(100.0,-5.0,NUOX,6H(F8.6),8)
138.        CALL  TVNUMB(100.0,-8.0,NUOY,6H(F8.6),8)
139.        CALL  TVNUMB(822.0,-5.0,AM,6H(E9.3),9)
140.        CALL  TVNUMB(822.0,-8.0,NUS,6H(E9.3),9)
141.        CALL  TVNUMB(390.0,-8.0,CSI,6H(E9.3),9)
142.        CALL  TVNUMB(816,960.,ISCALE,4H(I1),1)
143.        CALL  TVGRPH(X1,Y3,-N)
144.        CALL  TVTEXA(0.0,0.0,2HJY,2,1)
145.   C
146.   C   ****!***************************************************************
147.        CALL  TVNEXT
148.   C   ****!***************************************************************
149.   C
150.        CALL  TVRNG(4HUSER,-10.0,-10.0,10.0,10.0)
151.        CALL  TVAX(1HX,1HY,1)
152.        CALL  TVAX(1HY,2HPY,2)
153.        XX(1)=-10.0
154.        XX(2)=10.0
155.        XX(3)=10.0
156.        YY(1)=10.0
157.        YY(2)=10.0
158.        YY(3)=-10.0
159.        CALL  TVDRAW(XX,YY,3)
160.   C
161.        CALL  TVMODE(4HFULL)
162.        FLGTYP=.TRUE.
163.        CALL  TVSET(8HHARDCHAR)
164.        CALL  TVTEXT(16.0,27.0,8H3*NUOX=7,8,1)
165.        CALL  TVTEXT(-10.0,-11.0,5HNUOX=,5,1)
166.        CALL  TVTEXT(-10.0,-11.7,5HNUOY=,5,1)
167.        CALL  TVTEXT(5.0,-11.0,3HAM=,3,1)
168.        CALL  TVTEXT(5.0,-11.7,4HNUS=,4,1)
169.        CALL  TVTEXT(-4.0,-11.7,4HCSI=,4,1)
170.        CALL  TVNUMB(-8.0,-11.0,NUOX,6H(F8.6),8)
171.        CALL  TVNUMB(-8.0,-11.7,NUOY,6H(F8.6),8)
172.        CALL  TVNUMB(7.0,-11.0,AM,6H(E9.3),9)
173.        CALL  TVNUMB(7.0,-11.7,NUS,6H(E9.3),9)
174.        CALL  TVNUMB(-2.0,-11.7,CSI,6H(E9.3),9)
175.        CALL  TVPLOT(X4,Y4,N)
176.   C
177.   C   ****!***************************************************************
178.        CALL  TVNEXT
179.   C   ****!***************************************************************
180.   C
181.        CALL  TVRNG(4HUSER,-10.0,-10.0,10.0,10.0)
182.        CALL  TVAX(1HX,1HX,1)
183.        CALL  TVAX(1HY,1HY,1)
184.        XX(1)=-10.0
185.        XX(2)=10.0
           XX(3)=10.0
```

```
186.      YY(1)=10.0
187.      YY(2)=10.0
188.      YY(3)=-10.0
189.      CALL TVDRAW(XX,YY,3)
190.  C
191.      CALL TVMODE(4HFULL)
192.      FLGTYP=.TRUE.
193.  C
194.      CALL TVSET(8HHARDCHAR)
195.      CALL TVTEXT(16.0,27.0,8H3*NUOX=7,8,1)
196.      CALL TVTEXT(-10.0,-11.0,5HNUOX=,5,1)
197.      CALL TVTEXT(-10.0,-11.7,5HNUOY=,5,1)
198.      CALL TVTEXT(5.0,-11.0,3HAM=,3,1)
199.      CALL TVTEXT(5.0,-11.7,4HNUS=,4,1)
200.      CALL TVTEXT(-4.0,-11.7,4HCSI=,4,1)
201.      CALL TVNUMB(-8.0,-11.0,NUOX,6H(F8.6),8)
202.      CALL TVNUMB(-8.0,-11.7,NUOY,6H(F8.6),8)
203.      CALL TVNUMB(7.0,-11.0,AM,6H(E9.3),9)
204.      CALL TVNUMB(7.0,-11.7,NUS,6H(E9.3),9)
205.      CALL TVNUMB(-2.0,-11.7,CSI,6H(E9.3),9)
206.      CALL TVPLOT(X2,X4,N)
207.  C
208.  C ****!**********************************************************
209.      CALL TVEND
210.  C ****!**********************************************************
211.  C
212.   90 FORMAT(1X,6(D13.7),I8)
213.  100 FORMAT(D13.7)
214.  200 FORMAT(I1)
215.      STOP
216.      END
217.  /*
218.  //G.FT11F001 DD DSN=&&DISPLY,DISP=(NEW,PASS),
219.  //           UNIT=SCR,SPACE=(CYL,(5,1),RLSE)
220.  //G.FT20F001 DD DSN=PZ.DLI.MAPDAT,DISP=SHR
221.  //   EXEC TXPLOT,PICLIB='PZ.DLI.PLIB ,TITLE='J/N;P/Q Plot',TERM=4006
222.  //   EXEC GD3VT
```

**A END   JOB   335 DLIPZ730 ***LIST OFFLINE   ROOM XC   11.53.13 AM 05 DEC 86 R51.PR1   SYS 7890 JOB 335 CP=   1   END A*

```
     1.    //DLILYAP JOB DLI$PZ,TIME=(1,58)
     2.    // EXEC JFORTCG,GRGN=2000K
     3.    //*NOTIFY DLI$PZ
     4.    //C.SYSIN DD *
     5.  C
     6.  C ***************************************************************
     7.  C ***!***********************************************************
     8.  C ***!***********************************************************
     9.  C ***                                                         ***
    10.  C ***                                                         ***
    11.  C ***           L Y A P   logarithmic plot                    ***
    12.  C ***                                                         ***
    13.  C ***                                                         ***
    14.  C ***************************************************************
    15.  C ***!***********************************************************
    16.  C ***!***********************************************************
    17.  C
    18.        DOUBLE PRECISION NUOX,NUOY,NUS,AM,CSI,SIGMA,XO,PXO,YO,PYO,NN
    19.        DOUBLE PRECISION DX,DPX,DY,DPY,DJX,DJY
    20.        DOUBLE PRECISION D2X,D2PX,D2Y,D2PY,D2JX,D2JY
    21.        DOUBLE PRECISION D3X,D3PX,D3Y,D3PY,D3JX,D3JY
    22.        REAL X1(5000),Y1(5000),X2(5000),Y2(5000),Y3(5000),X4(5000),
    23.       $Y4(5000)
    24.        INTEGER N,K
    25.        DIMENSION XX(3),YY(3)
    26.  C ***!***********************************************************
    27.        CALL TVBGN(11)
    28.  C ***!***********************************************************
    29.        READ(20,100) NUOX,NUOY,NUS,AM,CSI,SIGMA,XO,PXO,YO,PYO,NN
    30.        READ(30,100) NUOX,NUOY,NUS,AM,CSI,SIGMA,XO,PXO,YO,PYO,NN
    31.  C
    32.        K=0
    33.      1 K=K+1
    34.        READ(20,90,END=11)  D2X,D2PX,D2Y,D2PY,D2JX,D2JY,N
    35.        READ(30,90,END=11)  D3X,D3PX,D3Y,D3PY,D3JX,D3JY,N
    36.        DX=D2X-D3X
    37.        DPX=D2PX-D3PX
    38.        DY=D2Y-D3Y
    39.        DPY=D2PY-D3PY
    40.        Y1(K)=SQRT(DX**2+DPX**2+DY**2+DPY**2)
    41.        X1(K)=FLOAT(N)/10.
    42.        X2(K)=SNGL(DX)
    43.        Y2(K)=SNGL(DPX)
    44.        Y3(K)=SNGL(DJY)
    45.        X4(K)=SNGL(DY)
    46.        Y4(K)=SNGL(DPY)
    47.        GOTO 1
    48.     11 N=K-2
    49.  C
    50.        CALL TVMODE(4HLOGY)
    51.        CALL TVRNG(4HUSER,0.0,0.1E-06,1000.0,0.1E+08)
    52.        CALL TVAX(1HX,5HTURNS,5)
    53.        CALL TVAX(1HY,8HDISTANCE,8)
    54.        CALL TVTEXA(0.0,0.0,2HJX,2,1)
    55.  C
    56.  C
    57.        XX(1)=0.0
    58.        XX(2)=1000.0
    59.        XX(3)=1000.0
    60.        YY(1)=0.1E+08
    61.        YY(2)=0.1E+08
    62.        YY(3)=0.1E-06
```

```
63.          CALL TVDRAW(XX,YY,3)
64.    C
65.          FLGTYP=.TRUE.
66.          CALL TVSET(8HHARDCHAR)
67.          CALL TVMODE(4HFULL)
68.    C     CALL TVTEXT(480.0,950.0,8H3*NUOX=7,8,1)
69.          CALL TVTEXT(0.0,2.5E-08,5HNUOX=,5,1)
70.          CALL TVTEXT(0.0,1.0E-08,5HNUOY=,5,1)
71.          CALL TVTEXT(745.0,2.5E-08,3HAM=,3,1)
72.          CALL TVTEXT(728.0,1.0E-08,4HNUS=,4,1)
73.          CALL TVTEXT(300.0,1.0E-08,4HCSI=,4,1)
74.          CALL TVTEXT(680.,0.1E+07,12HHOR.SCALE*10,12,1)
75.          CALL TVNUMB(100.0,2.5E-08,NUOX,6H(F8.6),8)
76.          CALL TVNUMB(100.0,1.0E-08,NUOY,6H(F8.6),8)
77.          CALL TVNUMB(822.0,2.5E-08,AM,6H(E9.3),9)
78.          CALL TVNUMB(822.0,1.0E-08,NUS,6H(E9.3),9)
79.          CALL TVNUMB(390.0,1.0E-08,CSI,6H(E9.3),9)
79.1         CALL TVGRPH(X1,Y1,N)
80.          CALL TVNUMB(816,960,ISCALE,4H(I1),1)
81.    C
82.    C
83.    C     *****!*****************************************************
84.          CALL TVEND
85.    C     *****!*****************************************************
86.    C
87.    90    FORMAT(1X,6(D13.7),I8)
88.    100   FORMAT(D13.7)
89.    200   FORMAT(I1)
90.          STOP
91.          END
92.    /*
93.    //G.FT11F001 DD DSN=&&DISPLY,DISP=(NEW,PASS),
94.    //           UNIT=SCR,SPACE=(CYL,(5,1),RLSE)
95.    //G.FT20F001 DD DSN=PZ.DLI.MAPDAT2,DISP=SHR
96.    //G.FT30F001 DD DSN=PZ.DLI.MAPDAT3,DISP=SHR
97.    //          EXEC TXPLOT,PICLIB='PZ.DLI.PLIB',TITLE='J/N;P/Q Plot',TERM=4006
98.    //          EXEC GD3VT
```

A   END   JOB   337 DLIPZ731 ***LIST OFFLINE   ROOM XC   11.53.35 AM 05 DEC 86 R51.PR1   SYS 7890 JOB 337 CP=   1   END A*

```
 1.   //DLINUR   JOB DLI$PZ,TIME=(1,58)
 2.   //   EXEC  JFORTCG,LLB2='CR.PUB.PRO.GENLIB'
 3.   /*NOTIFY DLI$PZ
 4.   //C.SYSIN DD *
 5.   C
 6.   C ****!*********************************************************
 7.   C ****!*********************************************************
 8.   C ****!*********************************************************
 9.   C ****!*********************************************************
10.   C
11.   C            N U R A L L   ( all multipoles + random kick )
12.   C
13.   C ****!*********************************************************
14.   C ****!*********************************************************
15.   C ****!*********************************************************
16.   C ****!*********************************************************
17.   C
18.   C        NN       total number of turns (map iterations)
19.   C        CSI      coupling constant for the interaction
20.   C        SIGMA    variance of the transversal beam distribution
21.   C        NUOX     horizontal betatron tune
22.   C        NUOY     vertical betatron tune
23.   C        AM       betatron tune modulation amplitude
24.   C        NUS      betatron tune modulation frequency
25.   C        XO,PXO   initial coordinates in the horizontal phase space
26.   C        YO,PYO   initial coordinates in the vertical phase space
27.   C
28.   C
29.   C **********************************************************************************************
30.   C
31.         IMPLICIT REAL*8 (A-H,O-Z)
32.         REAL*8 NUOX,NUOY,NUS,NUX,NUY,NN
33.         REAL*8 MX,MDX,MY,MDY,NX,NDX,NY,NDY
34.         REAL*8 MXP,MDXP,MYP,MDYP,NXP,NDXP,NYP,NDYP
35.         REAL*8 JX,JY,JM
36.         COMPLEX CWERF,ZZ,ZW,ZN,ZWN,CEW
37.         EXTERNAL CWERF
38.   C     OPEN(UNIT=10,FILE='PZ.DLI.DDIRMAP',STATUS='OLD')
39.   C     OPEN(UNIT=20,FILE='PZ.DLI.PLOTMAP',STATUS='NEW')
40.         READ(5,100) NUOX,NUOY,NUS,AM,CSI,SIGMA,XO,PXO,YO,PYO,NN
41.         WRITE(6,90)
42.         WRITE(6,110) NUOX,NUOY,NUS,AM,CSI,SIGMA,NN
43.         WRITE(6,91)
44.         WRITE(6,111) XO,PXO,YO,PYO
45.         WRITE(6,112)
46.   C     WRITE(20,100) NUOX,NUOY,NUS,AM,CSI,SIGMA,XO,PXO,YO,PYO,NN
47.   C ****!*********************************************************
48.         DNU=0.2000000D-02
49.         DO 600 K=1,100
50.         NUOX=NUOX+DNU
51.         WRITE(6,101) NUOX,NUOY,K
52.   101   FORMAT(2(1X,D15.9),2X,'K=',I2)
53.   C ****!*********************************************************
54.         MM=20
55.         M=0
56.         JM=0.1000000D+03
57.         PI=4.00D+00*DATAN(1.0D+00)
58.         NUX=2.*NUOX/NUS
59.         NUY=2.*NUOY/NUS
60.         QQX=((NUX**2.)/2.)*AM
61.         QQY=((NUY**2.)/2.)*AM
```

```
 62.        QX=QQX/(NUX**2.)
 63.        QY=QQY/(NUY**2.)
 64.  C     *****!************************************************************
 65.        CX11=-QX/(4.*(NUX+1.))
 66.        CX12=QX/(4.*(NUX-1.))
 67.        CY11=-QY/(4.*(NUY+1.))
 68.        CY12=QY/(4.*(NUY-1.))
 69.  C     *****!************************************************************
 70.        N=0                           initial phase : 0 degr.
 71.  C
 72.        X=XO
 73.        PX=PXO
 74.  C                                   initial phase : 120 degr.
 75.  C     X=-XO*DSQRT(NUOX/2.0)/2.
 76.  C     PX=PXO*(DSQRT(3.)/2.)*DSQRT(NUOX/2.)
 77.  C                                   initial phase : 128 degr.
 78.  C     X=-XO*DSQRT(NUOX/2.0)*0.6156614746
 79.  C     PX=PXO*DSQRT(NUOX/2.0)*0.7880107541
 80.  C                                   initial phase : 90 degr.
 81.  C     X=XO
 82.  C     PX=NUOX*PXO
 83.  C     Y=YO
 84.  C     PY=PYO
 85.  C     SIGMAY=SIGMA
 86.  C     SIGMAX=4.0D+00*SIGMA
 87.  C     DSIGMA=SIGMAX**2-SIGMAY**2
 88.  C
 89.        GO TO 2
 90.  C     *****!************************************************************
 91.      1 N=N+1
 92.  C
 93.  C
 94.  C                                   ion-beam coupling constant on/off
 95.  C     CSI=0.000D+00
 96.  C                                   decentralization   on/off
 97.  C
 98.  C     XC=0.200D+01
 99.  C     X=X-XC
100.  C
101.  C                    cylindrical distribution ; SIGMAX=SIGMAY
102.  C     RQ=X**2+Y**2
103.  C     RN=RQ/(2.0D+00*SIGMA**2)
104.  C     PHI=(1.0D+00-DEXP(-RN))/RN
105.  C     EEX=X*PHI
106.  C     EEY=Y*PHI
107.  C
108.  C                    elliptical distribution ;   SIGMAX > SIGMAY
109.  C     IF(X.GT.174.0.OR.Y.GT.174.0) GO TO 599
110.  C     AMZZ=X**2+Y**2
111.  C     IF(AMZZ.GT.174) GO TO 599
112.  C     ZZ=CMPLX(X,Y)
113.  C     ZN=Z/DSQRT(2.0D+00*DSIGMA)
114.  C     ZW=CMPLX(X*(SIGMAY/SIGMAX),Y*(SIGMAX/SIGMAY))
115.  C     ZWN=ZW/DSQRT(2.0D+00*DSIGMA)
116.  C     CEW=CWERF(ZN)-
117.  C    $DEXP(.05D+00*((Y/SIGMAY)**2-(X/SIGMAX)**2))*CWERF(ZWN)
118.  C     EEX=AIMAG(CEW)/DSQRT(2.0D+00*PI*DSIGMA)
119.  C     EEY=REAL(CEW)/DSQRT(2.0D+00*PI*DSIGMA)
120.  C
121.  C
122.  C                                   random kick
123.  C
```

```
124.   C
125.   C       PP=RANF()
126.   C       IF(PP.LT.0.3) THEN
127.   C          AA=(1.0+3.*RANF())
128.   C          AA=(1.0*RANF())
129.   C          BB=2*(0.5-RANF())
130.   C       ELSE
131.   C          BB=0.0
132.   C
133.   C       ENDIF
134.   C       AA=(1.0+3.0*BB)
135.   C       AA=1.0
136.   C       CSI=CSI*AA
137.   C
138.   C
139.   C  ****!****************************************************************************
140.   C
141.        2  Z=PI*NUS*N
142.           ZX=Z-(QX/2.)*DSIN(2.*Z)
143.           ZY=Z-(QY/2.)*DSIN(2.*Z)
144.   C  ****!****************************************************************************
145.           CEX=DCOS(NUX*Z)+
146.          %   CX11*DCOS((NUX+2.)*Z)+CX12*DCOS((NUX-2.)*Z)
147.   C
148.           CEDX=-(NUX*DSIN(NUX*Z)+
149.          %   CX11*(NUX+2.)*DSIN((NUX+2.)*Z)+CX12*(NUX-2.)*DSIN((NUX-2.)*Z))
150.   C
151.           SEX=DSIN(NUX*Z)+
152.          %   CX11*DSIN((NUX+2.)*Z)+CX12*DSIN((NUX-2.)*Z)
153.   C
154.           SEDX=NUX*DCOS(NUX*Z)+
155.          %   CX11*(NUX+2.)*DCOS((NUX+2.)*Z)+CX12*(NUX-2.)*DCOS((NUX-2.)*Z)
156.   C  ****!****************************************************************************
157.           CEY=DCOS(NUY*Z)+
158.          %   CY11*DCOS((NUY+2.)*Z)+CY12*DCOS((NUY-2.)*Z)
159.   C
160.           CEDY=-(NUY*DSIN(NUY*Z)+
161.          %   CY11*(NUY+2.)*DSIN((NUY+2.)*Z)+CY12*(NUY-2.)*DSIN((NUY-2.)*Z))
162.   C
163.           SEY=DSIN(NUY*Z)+
164.          %   CY11*DSIN((NUY+2.)*Z)+CY12*DSIN((NUY-2.)*Z)
165.   C
166.           SEDY=NUY*DCOS(NUY*Z)+
167.          %   CY11*(NUY+2.)*DCOS((NUY+2.)*Z)+CY12*(NUY-2.)*DCOS((NUY-2.)*Z)
168.   C  ****!****************************************************************************
169.   C
170.           ALFAX=(NUX**2-QQX*2.*DCOS(2.*ZX))
171.           ALFAY=(NUY**2-QQY*2.*DCOS(2.*ZY))
172.           ZDX=(1.-QX*DCOS(2.*Z))
173.           ZDY=(1.-QY*DCOS(2.*Z))
174.           BETAX=-((ALFAX**(-1.25))/4.)*QQX*4.*DSIN(2.*ZX)*ZDX
175.           BETAY=-((ALFAY**(-1.25))/4.)*QQY*4.*DSIN(2.*ZY)*ZDY
176.           T=0.2500000D+00
177.           BBX=ALFAX**(T)
178.           BBY=ALFAY**(T)
179.           BX=1.0/BBX
180.           BY=1.0/BBY
181.           MX=BX*CEX
182.           MDX=(BETAX*CEX+BX*CEDX*ZDX)
183.           NX=BX*SEX
184.           NDX=(BETAX*SEX+BX*SEDX*ZDX)
185.   C
```

```
186.        MY=BY*CEY
187.        MDY=(BETAY*CEY+BY*CEDY*ZDY)
188.        NY=BY*SEY
189.        NDY=(BETAY*SEY+BY*SEDY*ZDY)
190.  C
191.        IF(N.EQ.0) GO TO 3
192.  C
193.        DELX=MDXP*NXP-MXP*NDXP
194.        DELY=MDYP*NYP-MYP*NDYP
195.        D1X=MDXP*NX-MX*NDXP
196.        D1Y=MDYP*NY-MY*NDYP
197.        D2X=MX*NXP-MXP*NX
198.        D2Y=MY*NYP-MYP*NY
199.        D3X=MDXP*NDX-MDX*NDXP
200.        D3Y=MDYP*NDY-MDY*NDYP
201.        D4X=MDX*NXP-MXP*NDX
202.        D4Y=MDY*NYP-MYP*NDY
203.  C **************************************************
204.  C
205.  C
206.  C
207.        X=(XP*D1X+(PXP-XP*CSP*2./NUS)*D2X)/DELX
208.        PX=(XP*D3X+(PXP-XP*CSP*2./NUS)*D4X)/DELX
209.        Y=(YP*D1Y+(PYP-YP*CSP*2./NUS)*D2Y)/DELY
210.        PY=(YP*D3Y+(PYP-YP*CSP*2./NUS)*D4Y)/DELY
211.  C
212.        X=(XP*D1X+(PXP-XP*CSP)*(2./NUS)*D2X)/DELX
213.        PX=(XP*D3X+(PXP-XP*CSP)*(2./NUS)*D4X)*NUS/(2.*DELX )
214.        Y=(YP*D1Y+(PYP-YP*CSP)*(2./NUS)*D2Y)/DELY
215.        PY=(YP*D3Y+(PYP-YP*CSP)*(2./NUS)*D4Y)*NUS/(2.*DELY)
216.  C
217.  C
218.        X=(XP*D1X+(PXP-CSI*EEX)*(2./NUS)*D2X)/DELX
219.        PX=(XP*D3X+(PXP-CSI*EEX)*(2./NUS)*D4X)*NUS/(2.*DELX )
220.        Y=(YP*D1Y+(PYP-CSI*EEY)*(2./NUS)*D2Y)/DELY
221.        PY=(YP*D3Y+(PYP-CSI*EEY)*(2./NUS)*D4Y)*NUS/(2.*DELY)
222.  C
223.     3  IF(X.GT.30.0.OR.PX.GT.30.0) GO TO 599
224.        EX=DSQRT((PX/NUOX)**2+X**2)
225.        EY=DSQRT((PY/NUOY)**2+Y**2)
226.  C **************************************************
227.  C
228.        XN=X*DSQRT(NUOX/2.)
229.        PXN=-PX/(DSQRT(2.*NUOX))
230.        JX=XN**2+PXN**2
231.        YN=Y*DSQRT(NUOY/2.)
232.        PYN=-PY/(DSQRT(2.*NUOY))
233.        JY=YN**2+PYN**2
234.  C **************************************************
235.        EE=(EX+EY)/2.
236.        IF(JX.GT.JM) GO TO 599
237.  C **************************************************
238.  C **************************************************
239.  C
240.        AN=N/1.
241.        AIN=AINT(AN)
242.        IF(AIN.EQ.AN) GO TO 5
243.        GO TO 6
244.     5  WRITE(6,200)   X,PX,Y,PY,EX,EY,N
245.        WRITE(20,202)  X,PX,Y,PY,JX,JY,N
246.        M=M+1
247.        IF(M.EQ.MM) GO TO 7
```

```fortran
248. C
249. C        GO TO 6
250. C      7 WRITE(6,250)
251. C        M=0
252. C
253. C ****!*********************************************************************
254. C
255.        6 XP=X
256.          PXP=PX
257.          YP=Y
258.          PYP=PY
259. C
260.          MXP=MX
261.          MDXP=MDX
262.          NXP=NX
263.          NDXP=NDX
264.          MYP=MY
265.          MDYP=MDY
266.          NYP=NY
267.          NDYP=NDY
268. C
269. C ****!*********************************************************************
270.          IF(N.EQ.NN) GO TO 590
271.          GO TO 1
272. C ****!*********************************************************************
273.       90 FORMAT(/,4X,'NUOX',6X,'NUOY',6X,'NUS',7X,'AM',8X,'CSI',7X,'SIGMA'
274.      %,5X,'NN')
275.       91 FORMAT(/,6X,'XO',8X,'PXO',7X,'YO',8X,'PYO')
276.      110 FORMAT(7(1X,D9.4))
277.      111 FORMAT(4(1X,D10.4))
278.      112 FORMAT(//)
279.      100 FORMAT(D13.7)
280.      200 FORMAT(6(1X,E10.4),1X,I8)
281.      202 FORMAT(1X,6(D13.7),I8)
282.      203 FORMAT(1X,E10.4)
283.      250 FORMAT(/,5X,'X',10X,'PX',9X,'Y',10X,'PY',9X,'EX',9X,'EY',12X,
284.      %'N')
285.      599 WRITE(6,200)  X,PX,Y,PY,EX,EY,N
286.      590 WRITE(10,1000) NUOX,N
287.     1000 FORMAT(D15.9,I8)
288.          WRITE(20,202) X,PX,Y,PY,JX,JY,N
289. C
290. C
291.        4 CLOSE(UNIT=10)
292.          CLOSE(UNIT=20)
293.      600 CONTINUE
294.          STOP
295.          END
/*
//G.SYSIN   DD
0.2200000D+01
0.2256500D+01
0.3000000D-01
0.1500000D-03
0.2000000D+01
0.1000000D+01
0.6000000D+02
0.0000000D+00
0.3000000D+02
0.0000000D+00
0.5000000D+04
/*
//*G.FT20F001 DD  DSN=PZ.DLI.NURDAT,UNIT=SYSDA,DISP=(NEW,CATLG),
//*            SPACE=(TRK,(2,1),RLSE)
```

```
310.     //G.FT10F001  DD  DSN=PZ.DLI.RESPDAT,UNIT=SYSDA,DISP=(MOD,CATLG),
311.     //        SPACE=(TRK,(2,1),RLSE)
```

**A END JOB 328 DLIPZ729 ***LIST OFFLINE   ROOM XC   11.52.35 AM 05 DEC 86 R51.PR1 SYS 7890 JOB 328 CP= 1 END A*

```
     1.    //DLIREAD JOB DLI$PZ,TIME=(1,58)
     2.    //  EXEC  JFORTCG
     3.    /*NOTIFY DLI$PZ
     4.    //C.SYSIN DD *
     5.    C
     6.    C
     7.    C     *****!*********************************************
     8.    C     *****!*********************************************
     9.    C
    10.    C                  R  E  A  D    data
    11.    C
    12.    C
    13.    C     *****!*********************************************
    14.    C     *****!*********************************************
    15.    C     *****!*********************************************
    16.          DOUBLE PRECISION NUOX
    17.          K=0
    18.       10 READ(10,1000,END=100) NUOX,N
    19.          WRITE(6,2000) NUOX,N
    20.          K=K+1
    21.          GO TO 10
    22.     1000 FORMAT(D15.9,I8)
    23.     2000 FORMAT(1X,D15.9,1X,I8)
    24.     3000 FORMAT(1X,'NUMBER OF DATA  :',I7)
    25.      100 WRITE(6,3000) K
    26.          STOP
    27.          END
    28.    /*
    29.    //G.FT10F001  DD  DSN=PZ.DLI.RESPDAT,UNIT=SYSDA,DISP=(OLD,CATLG)
```

```
1.     //DLIPRES JOB DLI$PZ,TIME=(1,58)
2.     // EXEC JFORTCG
3.     /*NOTIFY DLI$PZ
4.     //C.SYSIN DD *
5.   C
6.   C *****!*************************************************************
7.   C *****!*************************************************************
8.   C *****!*************************************************************
9.   C *****!*************************************************************
10.  C              P R E S
11.  C ******************************************************************
12.  C
13.  C *****!*************************************************************
14.  C *****!*************************************************************
15.  C *****!*************************************************************
16.  C *****!*************************************************************
17.  C
18.        DOUBLE PRECISION NUOX,NUOY,NUS,AM,CSI,SIGMA,XO,PXO,YO,PYO,NN
19.        DOUBLE PRECISION DX
20.        REAL X(1000),Y(1000)
21.        INTEGER N,K
22.        DIMENSION XX(3),YY(3)
23.  C *****!*************************************************************
24.        CALL TVBGN(11)
25.  C *****!*************************************************************
26.        READ(5,100) NUOX,NUOY,NUS,AM,CSI,SIGMA,XO,PXO,YO,PYO,NN
27.  C
28.        K=0
29.        READ(5,90) DX,N
30.        X(1)=SNGL(DX)
31.        YM=302.0
32.        Y(1)=YM/N
33.        DO 11 K=2,100
34.        READ(5,90) DX,N
35.        X(K)=SNGL(DX)
36.        Y(K)=FLOAT(N)
37.        Y(K)=YM/Y(K)
38.     11 CONTINUE
39.     12 N=K-1
40.  C
41.        CALL TVMODE(4HLOGY)
42.        CALL TVMODE(4HFULL)
43.        CALL TVRNG(4HUSER,2.26500,0.1E-01,2.27500,1.0)
44.        CALL TVAX(1HY,17HRELATIVE STRENGTH,17)
45.        CALL TVAX(1HX)
46.        CALL TVTEXT(2.26700,-0.5E-01,24HHORIZONTAL BETATRON TUNE,24,1)
47.        CALL TVGRPH(X,Y,N)
48.  C
49.        XX(1)=2.26500
50.        XX(2)=2.27500
51.        XX(3)=2.27500
52.        YY(1)=1.0
53.        YY(2)=1.0
54.        YY(3)=0.1E-01
55.        CALL TVDRAW(XX,YY,3)
56.        CALL TVEND
57.  C *****!*************************************************************
58.  C
59.     90 FORMAT(D15.9,1X,I8)
60.    100 FORMAT(D13.7)
61.        STOP
```

```
62.     END
63.     /*
64.     //G.SYSIN DD
65.     0.2359540D+01
66.     0.2265000D+01
67.     0.0780000D+00
68.     0.2000000D+00
69.     0.0000000D+00
70.     0.1000000D+01
71.     0.1000000D+02
72.     0.0000000D+00
73.     0.1000000D+02
74.     0.0000000D+00
75.     0.3000000D+06
76.01   0.2265100000D+01   5000
76.02   0.2265200000D+01   5000
76.03   0.2265300000D+01   5000
76.04   0.2265400000D+01   5000
76.05   0.2265500000D+01   5000
76.06   0.2265600000D+01   5000
76.07   0.2265700000D+01   5000
76.08   0.2265800000D+01   5000
76.09   0.2265900000D+01   5000
76.1    0.2266000000D+01   5000
76.11   0.2266100000D+01   5000
76.12   0.2266200000D+01   5000
76.13   0.2266300000D+01   5000
76.14   0.2266400000D+01   5000
76.15   0.2266500000D+01   5000
76.16   0.2266600000D+01   5000
76.17   0.2266700000D+01   5000
76.18   0.2266800000D+01   5000
76.19   0.2266900000D+01   5000
76.2    0.2267000000D+01   5000
76.21   0.2267100000D+01   5000
76.22   0.2267200000D+01   5000
76.23   0.2267300000D+01   5000
76.24   0.2267400000D+01   5000
76.25   0.2267500000D+01   5000
76.26   0.2267600000D+01   5000
76.27   0.2267700000D+01   5000
76.28   0.2267800000D+01   5000
76.29   0.2267900000D+01   5000
76.3    0.2268000000D+01   5000
76.31   0.2268100000D+01   5000
76.32   0.2268200000D+01   5000
76.33   0.2268300000D+01   5000
76.34   0.2268400000D+01   5000
76.35   0.2268500000D+01   5000
76.36   0.2268600000D+01   5000
76.37   0.2268700000D+01   5000
76.38   0.2268800000D+01   5000
76.39   0.2268900000D+01   5000
76.4    0.2269000000D+01   5000
76.41   0.2269100000D+01   5000
76.42   0.2269200000D+01   5000
76.43   0.2269300000D+01   5000
76.44   0.2269400000D+01   5000
76.45   0.2269500000D+01   5000
76.46   0.2269600000D+01   5000
76.47   0.2269700000D+01   5000
76.48   0.2269800000D+01   5000
```

```
76.49   0.22699000000D+01   5000
76.5    0.22700000000D+01   5000
76.51   0.22701000000D+01   5000
76.52   0.22702000000D+01   5000
76.53   0.22703000000D+01   5000
76.54   0.22704000000D+01   5000
76.55   0.22705000000D+01   5000
76.56   0.22706000000D+01   5000
76.57   0.22707000000D+01   5000
76.58   0.22708000000D+01   5000
76.59   0.22709000000D+01   5000
76.6    0.22710000000D+01   5000
76.61   0.22711000000D+01   5000
76.62   0.22712000000D+01   5000
76.63   0.22713000000D+01   5000
76.64   0.22714000000D+01   5000
76.65   0.22715000000D+01   5000
76.66   0.22716000000D+01   5000
76.67   0.22717000000D+01   5000
76.68   0.22718000000D+01   5000
76.69   0.22719000000D+01   5000
76.7    0.22720000000D+01   5000
76.71   0.22721000000D+01   5000
76.72   0.22722000000D+01   5000
76.73   0.22723000000D+01   5000
76.74   0.22724000000D+01   5000
76.75   0.22725000000D+01   5000
76.76   0.22726000000D+01   3569
76.77   0.22727000000D+01   5000
76.78   0.22728000000D+01   5000
76.79   0.22729000000D+01   5000
76.8    0.22730000000D+01   3280
76.81   0.22731000000D+01   4351
76.82   0.22732000000D+01   5000
76.83   0.22733000000D+01   1008
76.84   0.22734000000D+01   5000
76.85   0.22735000000D+01   1296
76.86   0.22736000000D+01   1075
76.87   0.22737000000D+01   3309
76.88   0.22738000000D+01   5000
76.89   0.22739000000D+01   406
76.9    0.22740000000D+01   1249
76.91   0.22741000000D+01   302
76.92   0.22742000000D+01   1024
76.93   0.22743000000D+01   2216
76.94   0.22744000000D+01   2399
76.95   0.22745000000D+01   1513
76.96   0.22746000000D+01   1908
76.97   0.22747000000D+01   532
76.98   0.22748000000D+01   2988
76.99   0.22749000000D+01   2288
77.     0.22750000000D+01
176.    /*
177.    //G.FT11F001 DD DSN=&&DISPLY,DISP=(NEW,PASS),
178.    //           UNIT=SCR,SPACE=(CYL,(5,1),RLSE)
179.    //    EXEC TXPLOT,PICLIB='PZ.DLI.PLIB',TITLE='reson. behav.',TERM=4006
180.    //    EXEC GD3VT
```