154
11/28/72

AD. 2359

LA-5076-MS

INFORMAL REPORT

Electro-Mechanical Tolerance Requirements
for Quadrupoles from the Beam
Optical Aberrations

los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87544

MASTER

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

In the interest of prompt distribution, this LAMS report was not edited by the Technical Information staff.

Printed in the United States of America. Available from
National Technical Information Service
U. S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151
Price: Printed Copy \$3.00; Microfiche \$0.95

LA-5076-MS

Informal Report

UC-28

ISSUED: November 1972

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

Electro-Mechanical Tolerance Requirements for Quadrupoles from the Beam Optical Aberrations

by

H. F. Vogel

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

GG

ELECTRO-MECHANICAL TOLERANCE REQUIREMENTS FOR QUADRUPOLES FROM THE BEAM OPTICAL ABERRATIONS

by

H. F. Vogel

ABSTRACT

The description of the trajectories as a Taylor's expansion uses a Green's function that contains only the first-order trajectories. These are computed by TRANSPORT and then used by the output program HIGHORD, which compares the high order perturbations of trajectories with the distortions of the quadrupole field from four types of electro-mechanical perturbations.

I. THE MAGNETIC FIELD

When the equations for the potentials

$$\vec{\nabla} \times \vec{A} = \vec{B} \quad (1a)$$

$$\vec{\nabla} \cdot \vec{A} = -\vec{H} \quad (1b)$$

are written in the complex $w = x+iy$ plane, then one may define the new scalar quantity

$$A = A_z / \mu_0, \quad (2)$$

where A_z is the only vector component of $\vec{A}$ in the Cartesian x, y, z system. μ_0 is the permeability of free space. The two equations (1a) and (1b) may then be combined in one complex potential,

$$F = A + i\phi. \quad (3a)$$

By differentiating Eq. (3a) with respect to w -- indicated by prime-- one gets the complex complement of the field gradient

$$H^* = iF'. \quad (3b)$$

Since $F = F(w)$ is analytical, it may be expanded in a Taylor series about the origin, i.e.,

$$F(w) = \sum_{n=0}^{\infty} \frac{w^n}{n!} F^{(n)}(0). \quad (4)$$

We have in Eq. (4) the binomial

$$w^n = \sum_{v=0}^{n/2} (-1)^v \binom{n}{2v} x^{n-2v} y^{2v} + i \sum_{v=0}^{(n-1)/2} (-1)^v \binom{n}{2v+1} x^{n-1-2v} y^{2v+1}. \quad (4a)$$

The even powers in y will not contribute to the potential ϕ , if we require median plane symmetry $\phi(x,y) = -\phi(x,-y)$. In each derivative

$$F^{(n)}(0) = \frac{\partial^n \phi}{\partial y \partial x^{n-1}} + i \frac{\partial^n \phi}{\partial x^n}, \quad (4b)$$

the imaginary part is consequently zero. Hence, Eq. (4) may be rewritten for the potential

$$\phi(w) = \sum_{n=0}^{\infty} C_n w^n, \quad (5)$$

where now

$$C_n = \frac{1}{n!} \frac{\partial^n \phi}{\partial y \partial x^{n-1}} = \frac{\partial^{n-1} H_y}{\partial x^{n-1}} \frac{1}{n!} \quad (5a)$$

and

$$w^n = \sum_{v=0}^{\infty} (-1)^v \binom{n}{2v+1} x^{n-1-2v} y^{2v+1} \quad (5b)$$

H_y in Eq. (5a) is the y component of the field gradient.

II. EQUATION OF MOTION

K. Brown writes¹ the solution of the equation of motion in the form

$$(x_1 | x_o^K y_o^\lambda x_o^\mu y_o^\nu \delta^X) = \left[\frac{n!}{\kappa! \lambda! \mu! \nu! \chi!} \right] \int_0^t G_1(t, \tau) c_x^K(\tau) c_y^\lambda(\tau) s_x^\mu(\tau) s_y^\nu(\tau) d_x^\chi(\tau) K_n(\tau) d\tau, \quad (6)$$

where the parentheses are symbols for the Taylor coefficients; the first part of the expression within the parentheses identifies the coordinate $x_1 = x$; y ; x' ; y' ; $\delta = \Delta p/p_o$, represented by the expansion; and the second part in the parentheses indicates the term in question. These Taylor coefficients are functions of the curvilinear coordinate τ used in TRANSPORT. $G_1(t, \tau)$ is a set of Green's functions, which have the most important property pointed out by Dr. Brown that they are just first order Taylor's coefficients measured from the location (τ) of the multipole component to the end of the system (t) ; i.e.,

$$G_1(t, \tau) = (x(t) | x'(\tau)) \quad (6a)$$

$$G_2(t, \tau) = (x'(t) | x'(\tau)) \quad (6b)$$

$$G_3(t, \tau) = (y(t) | y'(\tau)) \quad (6c)$$

$$G_4(t, \tau) = (y'(t) | y'(\tau)) \quad (6d)$$

Thus we see that the coupling coefficient to an n th order multipole is a function of only the first order trajectories, i.e., the cosine-like trajectories c_x , c_y , the sine-line trajectories s_x , s_y , and their

derivatives with respect to τ , i.e., c'_x , c'_y , s'_x , s'_y .

K_n in Eq. (6) is the n th order multipole strength per unit length given by

$$K_n(\tau) = \frac{1}{(B\rho)} \frac{1}{n!} \left(\frac{\partial^n B}{\partial x^n} y \right)_{x=y=0}, \quad (6f)$$

where

$$B\rho = \frac{p_o}{e}. \quad (6g)$$

III. FIELD PERTURBATIONS

By comparing the multipole strength per unit length used in the equation of motion, i.e., Eq. (6f), with the multipole coefficient in the two-dimensional field expansion, i.e., with Eq. (5a), we get

$$C_{n+1} = \frac{(B\rho)}{\mu_o} \frac{1}{n+1} K_n. \quad (7)$$

One can now correlate the aberration

$$(x_1 | x_o^K y_o^\lambda x_o^\mu y_o^\nu \delta^X) x_o^K y_o^\lambda x_o^\mu y_o^\nu \delta^X \quad (8)$$

with a perturbation of the potential ϕ , making use of the perturbation tables of K. Halbach.²

Let, thus, $x_1(t)$ be an acceptable $(n-1)$ order aberration. Assuming that the multipole strengths per unit length K_n are the same for all quadrupoles and that they are zero outside of quadrupoles, one can take K_n outside the integral of Eq. (6) to get

$$\begin{aligned} \langle K_n(t) \rangle_{\text{acceptable}} &= \\ &= \sum_{(\kappa, \lambda, \mu, \nu, \chi)} \left\{ \pm (x_1 | x_o^K y_o^\lambda x_o^\mu y_o^\nu \delta^X)_{\text{acceptable}} \right. \\ &\quad \left. \left[\frac{n!}{\kappa! \lambda! \mu! \nu! \chi!} \right] \int_0^t G_1 c_x^K c_y^\lambda s_x^\mu s_y^\nu d_x^\chi d\tau \right\}. \quad (9) \end{aligned}$$

The summation in Eq. (9) is taken over all those of the n^5 variations to the fifth class of n elements, for which $\kappa + \lambda + \mu + \nu + \chi = n$.

Values of $\left(\frac{C}{N} \frac{n}{C_N} \frac{a}{\Delta} \right)$ vs n and N have been tabulated in Dr. Halbach's report, where a is the aperture radius, Δ the electro-mechanical perturbation,

N is the order of the fundamental multipole field.
With Eq. (7) we get then

$$\left(\frac{n+1}{N+1} \frac{C_{n+1}}{C_{N+1}} \frac{a}{\Delta} \right)_{\text{table}} = \frac{a}{\Delta} \frac{(B\rho)}{\mu_0} \frac{n(N+1)!}{N+1} \frac{K_n}{dH/dx} \quad (10)$$

For N = 1, which is a quadrupole; and

$$dH/dx / (B\rho) = k^2 / \mu_0, \quad (11)$$

Eq. (10) may be rewritten

$$\left(\frac{a}{\Delta} \right)_{\text{acceptable}} = \frac{1}{\left(\frac{n+1}{N+1} \frac{C_{n+1}}{C_{N+1}} \frac{a}{\Delta} \right)_{\text{table}}} \frac{\langle K_n \rangle_{\text{acceptable}}}{k^2} \quad (12)$$

IV. PROCEDURE

The desired beam line is computed by TRANSPORT to first order. The trajectories c_x, c_y, s_x, s_y, d_x for the Green's functions are punched on cards at entrances, centers, and exits of all quadrupoles.

The program HIGHORD reads the cards and uses a modified Simpson's rule for recomputing the five trajectories in each quadrupole for Eq. (9). In the modified rule, the weight of the center elements is varied to satisfy the Jacobi Liouville identity. Halbach's table for the quadrupole is stored in the program for use in Eq. (12). The program prints out a table of $\left(\frac{a}{\Delta} \right)_{\text{acceptable}}$ numbers for $n = 0, 1, \dots, 5$.

The program, furthermore, prints out a set of multipole potentials as given by Eq. (10) for $N=1$, i.e.,

$$\frac{C_{n+1}}{C_2} = \frac{(B\rho)}{\mu_0} \frac{2n}{n+1} \frac{\langle K_n \rangle_{\text{acceptable}}}{k^2}, \quad (13)$$

which relate directly to permissible measured multipole errors, i.e., one writes

$$\frac{\partial^n H_y}{\partial x^n} / \frac{\partial H_y}{\partial x} = \frac{(n+1)!}{2} \frac{C_{n+1}}{C_2} \quad (14)$$

The program HIGHORD lists a table of $\left(\frac{C_{n+1}}{C_2} \right)$ values under the headings "C(n+1) = ____"; thus, if $C(6) = 10^{-6}$, then

$$\frac{\partial^5 H_y}{\partial x^5} / \frac{\partial H_y}{\partial x} \leq 3.6 \cdot 10^{-4} \text{ is acceptable.}$$

V. BEAM ROTATION

For a beam line with two orthogonal bending planes, for example the vertical and the horizontal planes, we rotate the beam through 90° just ahead of the first magnet that bends in the vertical plane, and then through -90° after the end of the vertical and ahead of the next horizontal bending section.

Thus, we have at the start of the vertical bending section

$$\begin{pmatrix} R_{11} & R_{12} & \dots & R_{16} \\ R_{21} & R_{22} & \dots & R_{26} \\ R_{31} & R_{32} & \dots & R_{36} \\ R_{41} & R_{42} & \dots & R_{46} \\ 0 & 0 & \dots & 1 \end{pmatrix}^{90^\circ} = \begin{pmatrix} R_{31} & R_{32} & R_{33} & R_{34} & R_{36} \\ R_{41} & R_{42} & R_{43} & R_{44} & R_{46} \\ -R_{11} & -R_{12} & -R_{13} & -R_{14} & -R_{16} \\ -R_{21} & -R_{22} & -R_{23} & -R_{24} & -R_{26} \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix} \quad (15)$$

Within the vertical bending section, the following transformation takes place

$$\begin{pmatrix} a & b & 0 & c \\ d & c & & f \\ 0 & A & B & 0 \\ 0 & D & E & 0 \\ 0 & & & 1 \end{pmatrix} \begin{pmatrix} 0 & R_{33} & R_{34} & 0 \\ R_{43} & R_{44} & & \\ -R_{11} & -R_{12} & & -R_{16} \\ -R_{21} & -R_{22} & 0 & -R_{26} \\ 0 & 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} 0 & bR_{33}+bR_{43} & aR_{34}+bR_{44} & c \\ dR_{33}+eR_{43} & dR_{34}+eR_{44} & & f \\ -AR_{11} & -BR_{11} & -AR_{12} & -BR_{12} & -AR_{16} & -BR_{16} \\ -DR_{11} & -ER_{11} & -DR_{12} & -ER_{12} & -DR_{16} & -ER_{16} \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \quad (16)$$

Since we assume symmetry about a median plane, the calculations must be carried out two times, once for the horizontal and once for the vertical plane of symmetry. The trajectories as taken from Eqs. (15) and (16) are then identified with elements of the transformation matrix as given in Table I.

VI. APPENDICES

Appendix I includes a Fortran listing of Program HIGHORD.

An aberrations calculation is carried out in the Appendices II-V for the LAMPF beam line D0. The beam line is broken up in two sections for the TRANSPORT computation because of the limited number of elements allowed by TRANSPORT. The trajectories R_{ij} listed in Appendices II and III are punched out and then combined in one beam line for HIGHORD. The permissible multipole normalized potentials C_{n+1} listed in Appendices IV and V are of course unaffected by the quadrupole gradients; whereas the resulting mechanical tolerances do depend on the quadrupole gradients.

Note that C(2) has never been normalized and the number printed for it is therefore meaningless. Likewise, those mechanical perturbations that do not couple to the multipole NN in the aberrations tables are set to 1000; therefore, any 1000-number in the table should be read as a blank.

VII. REFERENCES

1. Karl L. Brown, "A First- and Second-Order Matrix Theory for the Design of Beam Transport Systems and Charged Particle Spectrometers," SLAC-75.
2. Klaus Halbach, "First Order Perturbation Effects in Iron Dominated Two-Dimensional Multipoles," UCRL-18841.

TABLE I

Trajectory	Assuming Symmetry about Horizontal Plane		Assuming Symmetry about Vertical Plane	
	Before +90° Rotation and again after rotating back	Between +90° and -90° Rotations	Before +90° Rotation and again after rotating back	Between +90° and -90° Rotations
C_x	R_{11}	$-AR_{11} - BR_{21}$	$+R_{11}$	$aR_{33} + bR_{43}$
s_x	R_{12}	$-AR_{12} - BR_{22}$	$+R_{12}$	$aR_{34} + bR_{44}$
dx	R_{16}	$-AR_{16} - BR_{26}$	$+R_{16}$	c
C'_x	R_{21}	$-DR_{11} - ER_{21}$	$+R_{21}$	$dR_{33} + eR_{43}$
s'_x	R_{22}	$-DR_{12} - ER_{22}$	$+R_{22}$	$dR_{34} + eR_{44}$
C_y	R_{33}	$+aR_{33} + bR_{43}$	R_{33}	$-AR_{11} - BR_{21}$
s_y	R_{34}	$aR_{34} + bR_{44}$	R_{34}	$-AR_{12} - BR_{22}$
C'_y	R_{43}	$dR_{33} + eR_{43}$	R_{43}	$-DR_{11} - ER_{21}$
s'_y	R_{44}	$dR_{34} + eR_{44}$	R_{44}	$-DR_{12} - ER_{22}$

APPENDIX I Fortran Listing of Program HIGHORD

RUN-60K

10/10/72 09.21.11

```

*****PROGRAM TO COMPUTE THE ABBERATIONS THRU N=5 FROM QUADRUPOLES*****HI 0003
* IDENTITY----- X(J,I) = X(I)HI 0004
* WHERE J=1 XHI 0005
* J=2 XPHI 0006
* J=3 YHI 0007
* J=4 YPHI 0008
* T=T(I)HI 0009
* G(J,I) = GREEN-S FUNCTIONHI 0010
* IMAX = NUMBER OF SETS OF RR ELEMENTS, EACH SET=ONE FULL QUAD *HI 0011
* * LAST ELEMENTHI 0012
* DL= FULL LENGTH OF QUAD = 2*L/2HI 0013
* SDDY = STARTING Z FOR R ROTATED POSITIVELYHI 0014
* ENDROT = END Z FOR R ROTATED NEGATIVELYHI 0015
* NY= ORDER OF PERTURBATIONHI 0016
* IC= COMBINATION OF 5 ELEMENTS TO THE 5TH CLASS, WITH REPETITION, ANDHI 0017
* USED AS COUNTER UP TO THIS NUMBERHI 0018
* ICNT = COUNTER FOR ELEMENTS OF SETS IC THAT SATISFY MIDPLANE SYMM,HI 0019
* TIMES NO. OF ELEMENTS TO IMAXHI 0020
* AX0 )HI 0021
* AXP0 ) PERMISSIBLEHI 0022
* AY0 ) ABBERATIONSHI 0023
* AYP0 ) PHASE SPACEHI 0024
* GN STANDARD QUADRUPOLE GRADIENT IN TESLA / METERHI 0025
* P0 MOMENTUM IN GEV/CHi 0026
* IF .90 DEG ROT. WAS USED, THEN WE ROTATE BACK TO REFERENCE SYSTEM, ANDHI 0027
* CALCULATE THE ABBERATIONS FOR DX (HORIZONTAL) OR DY (VERT.) .NE. 0,HI 0028
* BUT NOT BOTH DX .NE. 0 AND DY .NE. 0HI 0029
* IVERT=1, IHOR=0 * INVESTIGATE VERTICAL PLANE, AND VICE VS. HI 0030
* ENTER IVERT, IHOR, BOTH IF ROTATION IS USED, OTHERWISE ENTER NONEHI 0031
* *****IMPORTANT NOTE OF HORROR*****HI 0032
* -----INCONSISTENT SYSTEM OF UNITS IN USE-----HI 0033
* TRANSPORT IS TO USE NO 15-CARD *HI 0034
* X0,Y0, AX0, AYG USE CM XPO,YPO, AXP0, AYP0 US, MR *HI 0035
* ON USE TESLA/METER, DO USE PERCENT, DL USE METER, P0 USE GEV/C *HI 0036
* *****INPUT*****HI 0037
* 1ST CARD 1 IN COL 1, FOLLOWED BY TITLEHI 0038
* -----OR***DECK OF CARDS PUNCHED OUT BY INCOMPLETE RUN OF HIGHORDHI 0039
* FORHI 0040
* EDITED DECK OF CARDS PUNCHED OUT BY TRANSPORTHI 0041
* NAMELISTS DIST, PHASE, ABBERTN, IN THIS SEQUENCEHI 0042
* (NOTE, THE LAST SET OF THREE CARDS MUST BE AT TAU=T, I.E. HI 0043
* AT THE CHANNEL-END, IF THIS IS NO QUADRUPOLE, THEN ENTER HI 0044
* THE CORRESPONDING DL(IMAX)=0. THIS LAST ELEMENT IS HI 0045
* IMPORTANT FOR THE GREEN-S FUNCTIONS ARE EVALUATED FROM TAUHI 0046
* TO T FOR EACH ELEMENT TAU(I) )HI 0047
* IN THIS SEQUENCE AS MANY TIMES AS PARAMETERS ARE TO BE RE- HI 0048
* ENTERED (REDEFINING OF IHOR, IVERT INEFFECTIVE, THOUGH)
* NAMELISTS, DIST, PHASE ONLY
* EOFHI 0049
*****HI 0050
*HI 0051
CONTROL CARDS-----HI 0052
% RUN(S)HI 0053
COPY,INPUT,XXX,2. HI 0054

% REWIND,XXX. HI 0055
COPYCF,XXX,OUTPUT,2. HI 0056
% REWIND,INPUT. HI 0057
COPYCK,INPUT,DUM,2. HI 0058
% LG0. HI 0059
% MODE 1. HI 0060
% EUR HI 0061
%*****HI 0062
*HI 0063
PROGRAM HIGHORD(INPUT, OUTPUT, TAPE1=INPUT, TAPE2=OUTPUT,PUNCH) HI 0064
REAL A(6), R16(6), C(6), D(6), E(6), R11(75), R12(75), R21(75), HI 0065
1 R22(75), R16(75), R33(75), R34(75), R43(75), R44(75), FF(150), HI 0066
2 G(4,75), XX(4,75), X(4,150), SIG(4), RR(4,6,3), COEFF(150,75), HI 0067
3 DL(75) HI 0068
REAL FK(4), TABLE(11,7), EPS(11,7), KSO,CHECK1(75),CHECK2(75) HI 0069
REAL TABLE1(7),TABLE2(7),TABLE3(7),TABLE4(7),TABLE5(7),TABLE8(7), HI 0070
TABLE6(7), TABLE9(7),TABLE10(7),TABLE11(7) TABLE7(7) HI 0071
INTEGER NC(11) HI 0072
LOGICAL FLAG HI 0073
COMMON R11, R12, R21, R22, R16, R33, R34, R43, R44 HI 0074
NAMELIST / DIST / IMAX, DL, ISROT1, ISROT2, IENDRT1, IENDRT2, IHOR,HI 0075
, IVERT HI 0076

```



```

000002      NAMELIST / PHASE / X0, Y0, XP0, HI 0081
-          YP0,00 / ABBERTIN / AX0,AXP0,AY0,AYP0, GN, PG HI 0082
000002      DATA CC,PI/2.99793*3.14159265/MC/0.1,2,3,4,5,6,7,8,9,13 / HI 0083
000002      DATA (TABLE 1(I),I=1,7)/.199,-.425,.075,4*.0/ HI 0084
000002      DATA (TABLE 2(I),I=1,7)/.25,-.516,.214,4*.0/ HI 0085
000002      DATA (TABLE 3(I),I=1,7)/.157,-.288,.29,4*.0/ HI 0086
000002      DATA (TABLE 4(I),I=1,7)/.0,-.068,.23,4*.0/ HI 0087
000002      DATA (TABLE 5(I),I=1,7)/-.0205,-.1,.1,4*.0/ HI 0088
000002      DATA (TABLE 6(I),I=1,7)/.0,-.045,.03,.1,4*.02,-.07,-.02/ HI 0089
000002      DATA (TABLE 7(I),I=1,7)/.0161,-.01,.01,4*.0/ HI 0090
000002      DATA (TABLE 8(I),I=1,7)/.0,-.013,.013,4*.0/ HI 0091
000002      DATA (TABLE 9(I),I=1,7)/.0,-.013,.013,4*.0/ HI 0092
000002      DATA (TABLE 10(I),I=1,7)/.0,0,0,0,2,-.08,-.03,0,2/ HI 0093
000002      DATA (TABLE 11(I),I=1,7)/3*.0,0,31,-.2,0,07,0/ HI 0094
000002      S(MPSON(I,J) = 0.16666666*HR(I,J,1)+4.*HR(I,J,2)+RR(I,J,3)) HI 0095
-          HI 0096
000021      DO 7832 I=1,7 HI 0097
000021      TABLE(1,I)=TABLE1(I) $TABLE(2,I)=TABLE2(I) $TABLE(3,I)=TABLE3(I) HI 0098
000032      TABLE(4,I)=TABLE4(I) $TABLE(5,I)=TABLE5(I) $TABLE(6,I)=TABLE6(I) HI 0099
000040      TABLE(7,I)=TABLE7(I) $TABLE(8,I)=TABLE8(I) $TABLE(9,I)=TABLE9(I) HI 0100
000044      TABLE(10,I)=TABLE10(I) $TABLE(11,I)=TABLE11(I) HI 0101
000052      7832 CONTINUE HI 0102
000054      FLAG = 0 HI 0103
000055      IVERT = IMOR = 10 HI 0104
000057      DO 25 I=1,6 HI 0105
000061      J=I-1 HI 0106
000062      25 A(I)=B(I)=C(I)=D(I)=E(I)=J HI 0107
000073      READ(1,100) $PUNCH 100 HI 0108
000102      100 FORMAT(80H HI 0109
-          HI 0110
000102      ISTART1=0 HI 0111
000103      667 READ(1,104) ISTART1,(EPS(ISTART1,I),I=1,7) HI 0112
000121      IF(EOF,1)666,667 HI 0113

000124      104 FORMAT(110,10X,3020/4020) HI 0114
000124      666 ISTART=ISTART1+1 HI 0115
000126      READ(1,DIST) $READ(1,PHASE) $READ(1,ABBERTIN) HI 0116
000137      IF(EOF,1)77778,77779 HI 0117
000142      77779 WRITE(2,DIST) $WRITE(2,PHASE) $WRITE(2,ABBERTIN) HI 0118
000153      IF(OR(IVERT.EQ.0,IMOR.EQ.0,IMOR.EQ.1)GOTO916HI 0119
000170      IMOR=1 $ IVERT = 0 HI 0120
000172      916 IF(IVERT+IMOR.NE.1.OR,IVERT+IMOR.NE.0) STOP 2 HI 0121
000205      WRITE(2,100) HI 0122
000211      KSO=CC*0.1*GH/PO*1E-4 HI 0123
000215      DO 1 JIMMY=ISTART,6 HI 0124
000217      NN=NC(JIMMY) HI 0125
000221      WRITE(2,101) NN HI 0126
000225      101 FORMAT(12) HI 0127
000226      IC=ICONT=0 HI 0128
000230      DO 24 I=1,4 HI 0129
000235      24 SIG(I)=0 HI 0130
000237      DO 3 I1=1,NN HI 0131
000240      DO 3 I2=1,NN HI 0132
000241      DO 3 I3=1,NN HI 0133
000242      DO 3 I4=1,NN HI 0134
000243      DO 3 I5=1,NN HI 0135
000244      TORDEM=A(I1)*B(I2)*C(I3)*D(I4)*E(I5) HI 0136
000253      IF(TORDEM.NE.NN) GO TO 3 HI 0137
-          HI 0138
000255      IC=IC+1 HI 0139
-          HI 0140
000257      K=A(I1) HI 0141
000261      L=B(I2) HI 0142
000262      M=C(I3) HI 0143
000264      N=D(I4) HI 0144
000266      IX=E(I5) HI 0145
-          WRITE(2,102) NN, IC, K, L, M, N, IX HI 0146
000271      IF(FLAG)GOTO 1005 HI 0147
000272      DO 26 I=1,IMAX HI 0148
000274      READ(1,902) Z1 HI 0149
000301      902 FORMAT(8,10,5) HI 0150
000301      BACKSPACE 1 HI 0151
000303      JENNY1=0 HI 0152
000304      IF(1.GE.ISROT1.AND,1.LE.IENDMT1).OR,1.GE.ISROT2.AND,1.LE. HI 0153
-          IENDMT2) JENNY1=1 HI A153
000327      JENNY = 2*JENNY1+ IMOR + 1 HI 0154
000332      GO TO(1001,1001,1475,1476), JENNY HI 0156
000341      DO 837 J=1,3 HI 0157
000343      READ(1,902) Z1, RR(1,1,J), RR(1,2,J), RR(2,1,J), RR(2,2,J), HI 0158
1 RR(3,1,J), RR(3,4,J) HI 0159
000400      READ(1,902) Z2, RR(4,3,J), RR(4,4,J), RR(1,6,J) HI 0160
000422      READ(1,902) Z3 HI 0161
000430      IF(1/2.NE.Z1.OR,Z3.NE.Z1) STOP 1 HI 0162
000442      837 CONTINUE HI 0163
000444      GO TO 1003 HI 0164
000445      1475 DO 838 J=1,3 HI 0165
000447      READ(1,902) Z1 HI 0166
000454      READ(1,902) Z2, DUM, DUM, DUM, RR(3,3,J), RR(3,4,J), RR(4,3,J) HI 0167
000504      READ(1,902)Z3, RR(4,4,J),RR(1,1,J), RR(1,2,J), RR(2,1,J),RR(2,2,J)HI 0168

```

```

      = . RR(1,6,J)
000522 IF(ZZ.NE.Z1.OR.Z3.NE.Z1) STOP 1
000554 DO 1004 I=1,2
000556 DO 1004 JJ=1,2
000566 RR(II,JJ,J) = -RR(II,JJ,J)
000567 1004 CONTINUE
000572 838 CONTINUE
000574 RR(1,6,J) = -RR(1,6,J)
000577 GO TO 1003
000600 1476 DO 1002 J=1,3
000602 READ(1,902) Z1
000607 READ(1,902) Z2,DUM,DUM,RR(1,6,J),RR(1,1,J),RR(1,2,J),RR(2,1,J)
000641 READ(1,902) Z3,RR(2,2,J),RR(3,3,J),RR(3,4,J),RR(4,3,J),RR(4,4,J)
000673 IF(ZZ.NE.Z1.OR.Z3.NE.Z1) STOP 1
000705 DO 1477 II=3,4 SDO 1477 JJ=3,4
000717 1477 RR(II,JJ,J)=-RR(II,JJ,J)
000723 1002 CONTINUE
000725 1003 CONTINUE
000727 R11(1)=SIMPSON(1,1)
000731 R12(1)=SIMPSON(1,2)
000735 R21(1)=SIMPSON(2,1)
000741 R22(1)=SIMPSON(2,2)
000745 R16(1)=SIMPSON(1,6)
000751 R33(1)=SIMPSON(3,3)
000755 R34(1)=SIMPSON(3,4)
000761 R43(1)=SIMPSON(4,3)
000765 R44(1)=SIMPSON(4,4)
000772 CHECK1(1)=R11(1)*R22(1)-R12(1)*R21(1)
000775 CHECK2(1)=R33(1)*R44(1)-R34(1)*R43(1)
001001 IF(ABS(CHECK1(1))-1.)-LT.0.1 .AND. ABS(CHECK2(1))-1.)-LT.0.1)990,991
001015 990 CM=SQRT(CHECK1(1)*CHECK2(1))
001021 R11(1)=R11(1)/CM SR33(1)=R33(1)/CM
001025 R12(1)=R12(1)/CM SR34(1)=R34(1)/CM
001027 R21(1)=R21(1)/CM SR43(1)=R43(1)/CM
001032 R22(1)=R22(1)/CM SR44(1)=R44(1)/CM
001034 R16(1)=R16(1)/CM
001036 991 CONTINUE
001036 CALL ZERD(1)
001040 WRITE(2,903)1,JENNY,R11(1),R12(1),R21(1),R22(1),R16(1),R33(1)
      , R34(1),R43(1),R44(1),CHECK1(1),CHECK2(1)
001076 903 FORMAT(1H0,12,15,9F10.5,10X,2F10.5)
001076 26 CONTINUE
001101 FLAG=-3
001102 1005 CONTINUE
001102 K1=L1+M1=N1=IX1=NN1=1
001110 DO 4 L1=1,K
001115 4 K1=K1+1
001120 DO 5 L1=1,L
001124 5 L1=L1+1
001127 DO 6 L1=1,M
001133 6 M1=M1+1
001136 DO 7 L1=1,N
001142 7 N1=N1+1
001145 DO 8 L1=1,IX
001151 8 IX1=IX1+1

001154 DO 9 L1=1,NN
001160 9 NN1=NN1+1
001163 FF(1C)=FLOAT(NN1)/FLOAT(K1*L1*M1*N1*IX1)
      * PPINT 102,1C,K1,L1,M1,N1,IX1,NN1,FF(1C)
001173 102 FORMAT(1H,71R,1P4E12.4)
001173 X(1,1C)=X(2,1C)=X(3,1C)=X(4,1C)=0
001202 DO 11 J=1,4
001203 MM=2
001203 IF(J.EQ.1.OR.J.EQ.2)MM=1
001214 GO TO(41,42),MM
001224 41 ISYMM1=L+N
001224 ISYMM2=L+N+4
001226 ISYMM3=L+N+2
001230 GO TO 43
001231 ISYMM1=L+N+1
001234 ISYMM2=L+N+5
001236 ISYMM3=L+N+3
001240 43 MOD1=MOD(1,SYMM1+2)
001242 MOD2=MOD(1,SYMM2+4)
001245 MOD3=MOD(1,SYMM3+4)
001250 11 CONTINUE
001252 DO 10 I=1,IMAX
001253 CX=R11(I)*K
001277 CY=R33(I)*L
001277 SX=R21(I)*M
001303 SY=R34(I)*N
001307 DX=R16(I)*IX
001313 CORRFF(1C)=CX*CY*SX*SY*DX
001317 G(1,1)=R12(IMAX)*R11(I) - R11(IMAX)*R12(I)
001323 G(2,1)=R22(IMAX)*R11(I) - R21(IMAX)*R12(I)
001326 G(3,1)=R34(IMAX)*R33(I) - R33(IMAX)*R34(I)
001331 G(4,1)=R44(IMAX)*R33(I) - R43(IMAX)*R34(I)

```

```

001334 IF (MOD1 .EQ. 0) GO TO 10 HI 0256
001335 IF (MOD2 .EQ. 0) SIGN=-1. HI 0257
001336 IF (MOD3 .EQ. 0) SIGN= 1. HI 0258
* HI 0259
001343 ICONT=1+ICONT HI 0260
001345 DO 1456 J=1,4 HI 0261
001346 XX(J,1)=SIGN*FF(1C)*G(J,1)*COEFF(1C,1)*DL(1) HI 0262
001347 X(J,1C)=X(J,1C)+XX(J,1) HI 0263
001347 1456 CONTINUE HI 0264
* HI 0265
* WRITE(2,1P5) 1C, ICONT, X, L, M, N, JX, COEFF(1C,1), FF(1C), (XX(J,1), J=1,4) HI 0266
* 1) HI 0267
001371 125 FORMAT(1H, 7I5, 1P2E12.4, 5X, 4E12.4) HI 0268
001371 10 CONTINUE HI 0269
001374 IF (400) .NE. 0) GO TO 3 HI 0270
001375 DO 3 J=1,4 HI 0271
001377 SIG(J)=X(J,1C)*X0**K*Y0**L*XP0**M*YP0**N*D0**IX + SIG(J) HI 0272
001377 3 CONTINUE HI 0273
001426 3 CONTINUE HI 0274
001451 IF=ICONT HI 0275
001452 DO 7463 J=1,4 HI 0276
001457 7463 SIG(J)=1E5*SIG(J) HI 0277
**THE F5 IS FOR THE GORY SET OF INPUT DIMENSIONS UNITS, HI 0278

*** SIG IS THEN THE ABERRATION * NN-ORDER MOMENT OF BEAM IN CM. MR HI 0279
001461 WRITE(2,103) NN, 1E, (SIG(J), J=1,4) HI 0280
001472 103 FORMAT(10H, NN=, I2, * ICONT = *, I3, * PHASE SPACE X, XP, Y, HI 0281
*Y, FOR K(NN) = 1 + *, 1P4E12.4/ ) HI 0282
001472 C(1)=AX0/ARS(SIG(1)) HI 0283
001474 FK(2)=AXP0/ARS(SIG(2)) HI 0284
001477 FK(3)=AY0/ARS(SIG(3)) HI 0285
001502 FK(4)=AYP0/ARS(SIG(4)) HI 0286
001505 DO 1745 I=1,4 HI 0287
001507 CALL RANGE(FK(I), INDX) HI 0288
001511 IF (INDEX .EQ. 1) FK(I)=1000. HI 0289
001515 1745 CONTINUE HI 0290
001517 CALL SORT(IND, FK) HI 0291
001523 NPLUS1=NN+1 HI 0292
001523 CNPLUS1=FLOAT(NN)/FLOAT(NN+1)*FK(IND)/KSO*GN HI 0293
001531 WRITE(2,700) NN, FK, FK(IND), NPLUS1, CNPLUS1 HI 0294
001547 700 FORMAT(1X, I2, 1P5F13.5, 5X, 2HC(, I2, 4H) = , E10.3/ 83X, 18(1H= ) //) HI 0295
*****PERMISSIBLE ERROR HI 0296
001547 DO 457 I=1,7 HI 0297
001551 IF (TABLE(JIMMY, I) .EQ. 0 .OR. FK(IND) .EQ. 1000) GO TO 8754 HI 0298
001543 FOS(JIMMY, I)= FK(IND)/(KSO*TABLE(JIMMY, I)) HI 0299
001571 GO TO 457 HI 0300
001571 8754 EPS(JIMMY, I) = 1000. HI 0301
001575 457 CONTINUE HI 0302
001577 DO 104 J=1, 104, JIMMY, (EPS(JIMMY, I), I=1,7) HI 0303
001615 1 CONTINUE HI 0304
001617 1111 CONTINUE HI 0305
001617 4-ITE(2,100) HI 0306
001623 IF (JENNY .EQ. 3) WRITE(2,1718) & IF (JENNY .EQ. 4) WRITE(2,1717) HI 0307
001637 1717 FORMAT(10H, H O R I Z O N T A L PLANE*) HI 0308
001637 1718 FORMAT(10H, V E R T I C A L PLANE*) HI 0309
001637 4-ITE(2,1112) AX0, AXP0, AY0, AYP0 HI 0310
001653 1112 FORMAT(///, *0*, HI 0311
10 HI 0312
20 AXP0= *FR, 4, * AY0= *FR, 4, * AYP0= *FR, 4, HI 0313
3/140.56X, *TOP H POLEPAIRS = 2*/ HI 0314
4/140.12X, *EPSILON = PERMISSIBLE ERROR / APERTURE RADIUS A*, 26X, 5X, *HI 0315
5/POLEFACE MODIFICATION BY 1 BUMP*/ HI 0316
6/140.12X, *ERROR EXCITATION*, 9X, *DISPLACEMENT OF 1 POLE ONLY*, HI 0317
7/140.4X, *PHI*, 9X, *1 POLE ONLY*, 12X, *RADIAL*, 13X, *AZIMUTHAL*, 23X, HI 0318
8/EPS = *, 14H * DPHI / A (RAD) / HI 0319
9/140.70X, * PHI = 45 DEG 55 DEG*, 9X, *65 DEG*, 9X, *75 DEG*) HI 0320
DO 1114 JIMMY=2,6 HI 0321
NN=NC(JIMMY) HI 0322
ICOLN=7 HI 0323
WRITE(2,1113) NN, (EPS(JIMMY, III), III=1, ICOLN) HI 0324
001677 1113 FORMAT(1H0, 4X, I2, 4X, 1P3(4X, A, E10.2, 5X), 4(2X, E10.2, 3X) ) HI 0325
001677 1114 CONTINUE HI 0326
001701 WRITE(2,9413) HI 0327
001705 9413 FORMAT(10H, WHERE A = APERTURE RADIUS, */ HI 0328
1/140.14X, *H = HEIGHT OF STEEL ADDED OVER DIFFERENTIAL RANGE DPHI, */ HI 0329
2/140.12X, *PHI = ANGLE #/ RESPECT TO NEUTRAL POTENTIAL AXIS*/ HI 0330
3/140.30X, * NN# = * QUADRUPOLE, NN=5 * OCTUPOLE*) HI 0331
001705 1STAP1=0 HI 0332
001705 GO TO 566 HI 0333

001707 77778 CALL EXIT HI 0334
001710 END HI 0335

```

PUN=60K

10/10/72 09.21.11

000004	SUBROUTINE SORT(IND, F)	HI 0336
000004	REAL F(4)	HI 0337
000004	FF=1E100	HI 0338
000005	DO 1 I=1,4	HI 0339
000007	IF (F(I) .GT. FF) GO TO 1	HI 0340
000013	IND=1 \$ FF=F(I)	HI 0341
000015	1 CONTINUE	HI 0342
000017	RETURN	HI 0343
000020	END	HI 0344

SUBPROGRAM LENGTH
000033

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS
1 * 000016

BLOCK NAMES AND LENGTHS

VARIABLE ASSIGNMENTS
FF *R 000031 I *I 000032

EXTERNAL ASSIGNMENTS
END

START OF CONSTANTS
000023

START OF TEMPORARIES
000025

START OF INDIRECTS
000027

UNUSED COMPILER SPACE
016480

PUN=60K

10/10/72 09.21.11

000002	SUBROUTINE ZERO(J)	HI 0345
000002	REAL M	HI 0346
000002	COMMON M(75,9)	HI 0347
000002	DO 1 I=1,9	HI 0348
000004	IF (ABS(M(I,1)) .GT. 1E-7) 1,2	HI 0349
000014	2 M(J,1) = 1E-7	HI 0350
000020	1 CONTINUE	HI 0351
000022	RETURN & END	HI 0352

SUBPROGRAM LENGTH
000036

FUNCTION ASSIGNMENTS

STATEMENT ASSIGNMENTS
1 * 000021 2 * 000015

BLOCK NAMES AND LENGTHS
* 001743

VARIABLE ASSIGNMENTS
1 *I 000015 M *R 00000001

EXTERNAL ASSIGNMENTS
END

START OF CONSTANTS
000025

START OF TEMPORARIES
000030

START OF INDIRECTS
000034

UNUSED COMPILER SPACE
016300

APPENDIX II

TRANSPORT, Beam Line D0 from accelerator end to the
double waist in the beam transfer tunnel.

PROG02P CH/10/72 14.05.32

LINE D0 TO CENTER DOUBLE WAIST SECOND ORDER -VOGEL0F 8/1/72

DATAFILE= 0

1.	.389	.301	.347	.293	1.0	.35	1.464	MEAM0
12.	.52	0.	0.	0.	.194	0.	0.	0.
17.	SFCOND							
16.	0.	5.0	3.8000000000		APT			
3.	FREE							
3.0	1.6945300000 DRI177							
2.0	1.2370000000 FFO							
4.000	.6514700000 3.2370000000 0.0000000000 DOKICKER							
2.0	1.2370000000 FFO							
3.0	.6000000000 DRI17A							
2.0	0.0000000000 FFI							
4.000	.5000000000 3.4040000000 0.0000000000 LAMM01							
2.0	2.0000000000 FFI							
3.0	.7500000000 DRI17B							
16.0	1.0 -1.0001073500 EPSILON							
2.0	-2.0000000000 FFI							
4.000	.5000000000 3.4040000000 .012 LAMB02							
2.0	4.0000000000 FFI							
16.0	1.0 0.0000000000 HFSET							
3.0	7.5367616600 ENDCOLL							
4.0	-1.3342738000 SINGUR							
5.000	.1000000000 -2.3017300305 2.0000000000 UCOLL							
3.0	.1500000000 SINGUR							
2.0	0.0000000000 FFI							
4.000	1.2875700200 4.4204641000 0.0000000000 JUNCTN							
2.0	0.0000000000 FFI							
3.0	.1705470000 DRI17							
2.0	.6250000000 T101							
5.000	.2000000000 1.5235401176 2.0000000000 T101							
2.0	-1.5000000000 T102							
5.000	.5000000000 -1.4202167004 2.0000000000 T102							
3.0	.1500000000 T103							
5.000	.2500000000 1.5235401176 2.0000000000 T103							
2.0	.6250000000 T104							
2.0	4.0000000000 FFI							
4.000	1.0172900000 3.8500000000 0.0000000000 HA1							
4.000	.0496100000 1.4520125000 0.0000000000 HA1P							
4.000	1.7905500000 3.8500000000 0.0000000000 HA2							
4.000	.0496100000 1.4520125000 0.0000000000 HA2P							
4.000	1.7905500000 3.8500000000 0.0000000000 HA3							
4.000	.0496100000 1.4520125000 0.0000000000 HA3P							
4.000	1.0172900000 3.8500000000 0.0000000000 HA4							
2.0	4.0000000000 FFI10							
3.0	.6250000000 T201							
5.000	.2500000000 2.6035678538 2.0000000000 T201							
3.0	.1500000000 T202							
5.000	.5000000000 -2.4194874183 2.0000000000 T202							
3.0	.1500000000 T203							
5.000	.2500000000 2.6035678538 2.0000000000 T203							
3.0	.6250000000 T204							
2.0	4.0000000000 FFI11							
4.000	1.0172900000 3.8500000000 0.0000000000 HA1							
4.000	.0496100000 1.4520125000 0.0000000000 HA1P							
4.000	1.7905500000 3.8500000000 0.0000000000 HA2							
4.000	.0496100000 1.4520125000 0.0000000000 HA2P							
4.000	1.7905500000 3.8500000000 0.0000000000 HA3							
4.000	.0496100000 1.4520125000 0.0000000000 HA3P							
4.000	1.0172900000 3.8500000000 0.0000000000 HA4							
2.0	4.0000000000 FFI12							
3.0	1.0000000000 DRI110							
13.	4. HEFORERECT							
20.000	90.0000000000 ROT1							
3.0	1.0000000000 DRI1							
2.0	0. FFI13							
4.000	1.5196829600 3.8000000000 0.0000000000 HTW1A							
4.000	.0996100000 1.4520000000 0.0000000000 HTW1B							
4.000	1.4432029600 3.8000000000 0.0000000000 HTW1C							
4.000	.0996100000 1.4520000000 0.0000000000 HTW1D							
4.000	1.5196829600 3.8000000000 0.0000000000 HTW1E							
2.0	0. FFI14							
3.0	1.1440000000 DRI12							
5.000	.5000000000 3.0400000000 4.0000000000 DITR							
3.0	.0370000000 DRI13							
5.000	.5000000000 -2.7160000000 4.0000000000 DITR							
3.0	1.7100000000 DRI14							
5.000	.5000000000 4.1160000000 4.0000000000 DITR							
3.0	1.7100000000 DRI15							
5.000	.5000000000 -2.1160000000 4.0000000000 DITR							
3.0	.0370000000 DRI16							

5.000 .5000000000 3.0400000000 4.0000000000 NSTN
 3.0 1.1340000000 NTH7
 2.0 0.0 FF15
 4.000 1.5196824000 -3.0000000000 0.0000000000 RTW2A
 4.000 .0496100000 -1.0000000000 0.0000000000 RTW2B
 4.000 1.6433024000 -3.0000000000 0.0000000000 RTW2C
 4.000 .0496100000 -1.0000000000 0.0000000000 RTW2D
 4.000 1.5196824000 -3.0000000000 0.0000000000 RTW2E
 2.0 0.0 FF16
 3.0 11.0217030000 0.0000000000
 5.0 .2500000000 -2.0000000000 4.0000000000 0.0000000000 0.0000000000
 3.0 .2500000000 0.0000000000 0.0000000000 0.0000000000 0.0000000000
 5.0 .5000000000 2.0000000000 4.0000000000 0.0000000000 0.0000000000
 3.0 .2500000000 0.0000000000 0.0000000000 0.0000000000 0.0000000000
 5.0 .2500000000 -3.0000000000 4.0000000000 0.0000000000 0.0000000000
 2.0 55.5 0.0000000000 0.0000000000
 3.0 0.0000000000 0.0000000000 0.0000000000 0.0000000000 0.0000000000
 13. 4.0 AFTERBENT

SENTINEL

1.00000 .30000 .30100 .34700 .24300 1.00000 .35000 1.46400
 12.00000 .52000 0.00000 0.00000 0.00000 0.00000 .19400 0.00000
 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000
 17.00000
 16.00000 5.00000 3.00000
 3.00000 0.30000
 3.00000 1.00000
 2.00000 1.23700
 4.00000 .65147 3.23700 0.00000
 2.00000 1.23700
 3.00000 .40000
 2.00000 0.00000
 4.00000 .50000 3.40900 0.00000
 2.00000 2.00000
 3.00000 .75000
 16.00000 1.00000 -.00011
 2.00000 -2.00000
 4.00000 .50000 3.40900 .01200
 2.00000 4.00000
 17.00000 1.00000 0.00000

SEAM0
 TIL0
 SECC0D
 APT
 FREE
 URIFT7
 FFO
 UOKICKER
 FFO
 DRIFT7A
 FF1
 LAMM01
 FF2
 DRIFTB
 EPSILON
 FF3
 LAMM02
 FF4
 RESET.

-----TRAJECTORIES-----

LINE NO TO CENTER CIRCLE NAISI SECOND ORDER -VUGEPUGVQZP 08/30/72 14.07.03
 CHECK

1.000 .5200.0000.0000.0000.000 .1940.0000.0000.0000.0000.0000.0000.0000.000

.099
 3.0 0.30000 FREE
 3.0 1.00000 DRIFT7
 4.000 .651 3.237000 0.00 DOKICKER
 3.0 .40000 DRIFT7A
 4.000 .500 3.409000 0.00 LAMM01
 3.0 .75000 DRIFTA
 4.000 .500 3.409000 .01 LAMM02
 3.0 7.53676 SINGCCLL
 3.0 .13300 SINGC01
 5.000 .100 -2.367130 2.000 WCOLL
 3.0 .15000 SINGC02
 4.000 1.2000 0.000000 0.00 JUNCTN
 3.0 .17055 DRIFT
 3.0 .07500 T101
 5.000 .250 1.523540 2.000 T101
 3.0 .15000 T102
 5.000 .500 -0.920217 2.000 T102
 3.0 .15000 T103
 5.000 .250 1.523540 2.000 T103
 3.0 .07500 T104
 4.000 1.017 3.000000 0.00 HAM1
 4.000 .100 1.000000 0.00 HAM1P
 4.000 1.791 3.000000 0.00 HAM2
 4.000 .100 1.000000 0.00 HAM2P
 4.000 1.791 3.000000 0.00 HAM3
 4.000 .100 1.000000 0.00 HAM3P
 4.000 1.017 3.000000 0.00 HAM4
 3.0 .07500 T201
 5.000 .250 2.000000 2.000 T201
 3.0 .15000 T202
 5.000 .500 -2.000000 2.000 T202
 3.0 .15000 T203
 5.000 .250 2.000000 2.000 T203
 3.0 .07500 T204
 4.000 1.017 3.000000 0.00 HAM1
 4.000 .100 1.000000 0.00 HAM1P
 4.000 1.791 3.000000 0.00 HAM2
 4.000 .100 1.000000 0.00 HAM2P
 4.000 1.791 3.000000 0.00 HAM3
 4.000 .100 1.000000 0.00 HAM3P
 4.000 1.017 3.000000 0.00 HAM4
 3.0 1.00000 DRIFT7A
 20.000 40.000 HAM1
 3.0 1.00000 DRIFT7A
 4.000 1.520 3.000000 0.00 HAM1A
 4.000 .100 1.000000 0.00 HAM1H

4.000 1.493 3.460000 0.00 RIM1C
 4.000 1.100 1.452000 0.00 RIM1D
 4.000 1.420 3.460000 0.00 RIM1E
 2.0 1.13400 DTH2
 4.000 .500 3.040000 4.000 W1TH
 2.0 .83700 DTH3
 4.000 .500 -2.776000 4.000 W2TH
 2.0 1.70100 DTH4
 4.000 .500 4.176000 4.000 W3TH
 2.0 1.70100 DTH5

 4.000 .500 -2.776000 4.000 W4TH
 2.0 .83700 DTH6
 4.000 .500 3.040000 4.000 W5TH
 2.0 1.13400 DTH7
 4.000 1.520 -3.200000 0.00 RIM2A
 4.000 .100 -1.952000 0.00 RIM2B
 4.000 1.493 -3.400000 0.00 RIM2C
 4.000 .100 -1.952000 0.00 RIM2D
 4.000 1.520 -3.400000 0.00 RIM2E
 2.0 11.02170 D1TUNN
 4.000 .250 -2.877024 4.000 W1TUNN
 2.0 .25000 D2TUNN
 4.000 .500 2.476473 4.000 W2TUNN
 2.0 .25000 D3TUNN
 4.000 .250 -3.084800 4.000 W3TUNN
 2.0 55.50000 DLOC6
 20.000-50.000 POT2

-----TRAJECTORIES-----

LINE NO TO CENTER DOUBLE WAYS! SECOND UNDER -VUGEMUOV02P OR/30/72 14.07.03

7	NAME	R(1.1)	R(1.2)	R(1.3)	R(1.4)	R(1.5)	R(1.6)
0.00	T10	.1000E+01	0.	0.	0.	0.	0.
0.3A	FREE	.1000E+01	.8300E+00	0.	0.	0.	0.
10.00	DRIFT1	.1000E+01	.1000E+01	0.	0.	0.	0.
10.73	DOMICHEL	.1000E+01	.1073E+01	0.	0.	.1400E+01	0.
11.13	DRIFT2A	.1000E+01	.1113E+01	0.	0.	.1134E+01	0.
11.63	LAMMO1	.9994E+00	.1102E+01	0.	0.	.6164E+01	0.
12.34	DRIFT2	.9994E+00	.1234E+01	0.	0.	.1202E+00	0.
12.88	LAMMO2	.9978E+00	.1205E+01	0.	0.	.1678E+00	0.
20.42	FRICOLL	.9978E+00	.2041E+01	0.	0.	.1021E+01	0.
20.44	STICOM1	.9978E+00	.2034E+01	0.	0.	.1036E+01	0.
20.44	OCALLES	.1010E+01	.2009E+01	0.	0.	.1060E+01	0.
20.44	STICOM2	.1040E+01	.2180E+01	0.	0.	.1115E+01	0.
22.00	JURGIN	.1320E+01	.2471E+01	0.	0.	.1712E+01	0.
22.00	DRIFT	.1350E+01	.2451E+01	0.	0.	.1806E+01	0.
22.00	T101	.1443E+01	.3257E+01	0.	0.	.2153E+01	0.
22.00	T102	.1430E+01	.3200E+01	0.	0.	.2195E+01	0.
22.00	T103	.1378E+01	.3080E+01	0.	0.	.2140E+01	0.
22.00	T104	.1340E+01	.3034E+01	0.	0.	.2242E+01	0.
22.00	T105	.1374E+01	.3160E+01	0.	0.	.2349E+01	0.
22.00	T106	.1360E+01	.3160E+01	0.	0.	.2411E+01	0.
22.00	T107	.1174E+01	.2770E+01	0.	0.	.2273E+01	0.
24.00	HAI	.6325E+00	.1643E+01	0.	0.	.2000E+01	0.
24.00	HAI2	.6021E+00	.1401E+01	0.	0.	.1942E+01	0.
24.00	HAI3	.5072E+01	.4200E+00	0.	0.	.1944E+01	0.
24.00	HAI4	.1994E+01	.3645E+00	0.	0.	.1944E+01	0.
24.00	HAI5	.4321E+00	.1766E+00	0.	0.	.2121E+01	0.
24.00	HAI6	.5622E+00	.8330E+00	0.	0.	.2137E+01	0.
24.00	HAI7	.1111E+01	.1401E+01	0.	0.	.2533E+01	0.
24.00	HAI8	.1301E+01	.2375E+01	0.	0.	.2715E+01	0.
24.00	T201	.1264E+01	.2716E+01	0.	0.	.2556E+01	0.
24.00	T202	.1174E+01	.2715E+01	0.	0.	.2324E+01	0.
24.00	T203	.1232E+01	.2716E+01	0.	0.	.2226E+01	0.
24.00	T204	.1350E+01	.2574E+01	0.	0.	.2357E+01	0.
24.00	T205	.1443E+01	.2755E+01	0.	0.	.2470E+01	0.
24.00	T206	.1351E+01	.2643E+01	0.	0.	.2120E+01	0.
24.00	HAI1	.1044E+01	.2234E+01	0.	0.	.1235E+01	0.
24.00	HAI2	.1064E+01	.2217E+01	0.	0.	.1193E+01	0.
24.00	HAI3	.7834E+00	.1793E+01	0.	0.	.5579E+00	0.
24.00	HAI4	.7674E+00	.1708E+01	0.	0.	.5294E+00	0.
24.00	HAI5	.4670E+00	.1308E+01	0.	0.	.1428E+00	0.
24.00	HAI6	.4444E+00	.1244E+01	0.	0.	.1244E+00	0.
24.00	HAI7	.1344E+00	.1844E+00	0.	0.	.1353E+02	0.
24.00	DRIFT10	.1944E+00	.2716E+00	0.	0.	.1133E+02	0.
24.00	DTW1	.9444E+00	.4417E+00	.3664E+00	.1124E+01	.1634E+11	.4524E+00
24.00	DTW2	.1444E+00	.1100E+00	.2547E+00	.1217E+01	.8475E+01	.7879E+00
24.00	DTW3	.1444E+00	.1200E+00	.2547E+00	.1227E+01	.1017E+00	.8052E+00
24.00	DTW4	.1444E+00	.1430E+00	.1430E+00	.1293E+01	.3694E+00	.1065E+01
24.00	DTW5	.1444E+00	.1430E+00	.1430E+00	.1293E+01	.3431E+00	.1082E+01
24.00	DTW6	.2322E+00	.2474E+00	.2480E+01	.1350E+01	.8441E+00	.1346E+01
24.00	DTW7	.2474E+00	.3171E+00	.5650E+01	.1383E+01	.1244E+01	.1343E+01
24.00	DTW8	.2254E+00	.2771E+00	.8432E+01	.1134E+01	.1175E+01	.1466E+01
24.00	DTW9	.3434E+00	.1153E+00	.4577E+01	.3120E+00	.6559E+00	.3142E+01
24.00	DTW10	.8434E+00	.3203E+00	.1231E+00	.1527E+00	.4471E+00	.3343E+01
24.00	DTW11	.2234E+00	.2244E+00	.2405E+00	.1807E+01	.2049E+01	.1733E+01
24.00	DTW12	.2234E+00	.2234E+00	.2544E+00	.1770E+01	.9413E+01	.1744E+01
24.00	DTW13	.1434E+00	.3416E+00	.1212E+00	.1407E+00	.4473E+00	.3265E+01
24.00	DTW14	.5574E+00	.1873E+00	.2507E+00	.1350E+00	.6344E+00	.3144E+01

67.04	RTA6	.1763E-08	.1082E-08	-.5446E+00	-.1886E+01	-.1113E+01	-.1880E+01
67.05	RTA7	.2105E-08	.1378E-08	-.6031E+00	-.2174E+01	-.1171E+01	-.1474E+01
67.06	RTA8	.1974E-08	.1466E-08	-.4644E+00	-.1881E+01	-.7775E+00	-.1242E+01
67.07	RTA9	.1785E-08	.1573E-08	-.2444E+00	-.1477E+01	-.3360E+00	-.4321E+00
67.08	RTA10	.1772E-08	.1579E-08	-.2761E+00	-.1450E+01	-.3129E+00	-.4117E+00
67.09	RTA11	.1561E-08	.1602E-08	-.4377E+01	-.1032E+01	-.5528E+01	-.6088E+00
67.10	RTA12	.1546E-08	.1607E-08	-.4153E+01	-.1004E+01	-.4402E+01	-.5884E+00
67.11	RTA13	.1310E-08	.1702E-08	.1053E+00	-.5641E+00	.3486E+01	.2700E+00
67.12	RTA14	.4729E-08	.2086E-08	.1458E+01	.2659E+01	.4594E+01	.1974E+01
67.13	RTA15	.5380E-08	.2171E-08	.1557E+01	.4857E+01	.4493E+01	.1934E+01
67.14	RTA16	.6225E-08	.2375E-08	.1724E+01	.3182E+01	.5615E+01	.1804E+01
67.15	RTA17	.6740E-08	.2350E-08	.1734E+01	.4225E+01	.5780E+01	.1870E+01
67.16	RTA18	.6374E-08	.2103E-08	.1574E+01	.2942E+01	.5319E+01	.2007E+01
67.17	RTA19	.6370E-08	.1971E-08	.1484E+01	.2400E+01	.5116E+01	.2181E+01
67.18	RTA20	.6313E-08	.1874E-08	.1384E+01	.2334E+01	.5128E+01	.2066E+01

-----TRAJECTORIES-----

LINE NO TO CENTER COLUMN# MAJIS SECOND UNDER -VUGRPU0V02W 09/30/72 14.07.03

7	NAME	R(3.2)	R(3.3)	R(3.4)	R(3.6)	T(1.1.6)	T(1.2.6)
0.00	TTL0	0.	.1090E+01	0.	0.	0.	0.
0.32	EPF0	0.	.1800E+01	.4440E+00	0.	0.	0.
10.00	CRIFT7	0.	.1000E+01	.1000E+01	0.	0.	0.
10.73	NOCKICKR	0.	.9992E+00	.1072E+01	0.	.4323E-05	.1090E-04
11.13	CRIFT1A	0.	.9982E+00	.1111E+01	0.	.4329E-05	.4637E-05
11.67	LAMH01	0.	.9970E+00	.1100E+01	0.	.3694E-04	.4123E-04
12.30	DRIFTM	0.	.9938E+00	.1231E+01	0.	.3659E-04	.3885E-04
12.40	LAMH02	0.	.9926E+00	.1240E+01	0.	.1128E-03	.1368E-03
20.42	ENRCOLL	0.	.9423E+00	.1475E+01	0.	.4141E-03	.1088E-02
20.55	SINGH01	0.	.9414E+00	.1467E+01	0.	.4303E-03	.1103E-02
21.05	GCOLL	0.	.9293E+00	.1472E+01	0.	.4309E-03	.8762E-03
21.40	SINGH02	0.	.8943E+00	.1414E+01	0.	.5154E-03	.1802E-03
22.19	JUNCTN	0.	.5920E+00	.1417E+01	0.	.2456E-03	.1075E-03
22.26	DRIFT	0.	.5552E+00	.1352E+01	0.	.5110E-04	.4746E-03
22.40	T101	0.	.4108E+00	.1112E+01	0.	.1139E-02	.3421E-02
23.13	T101	0.	.3722E+00	.1070E+01	0.	.4026E-03	.2604E-02
23.20	T102	0.	.3602E+00	.1075E+01	0.	.1449E-03	.1137E-02
23.70	T102	0.	.2401E+00	.9644E+00	0.	.5106E-03	.3322E-03
23.93	T103	0.	.2451E+00	.9814E+00	0.	.2576E-03	.2547E-03
24.14	T103	0.	.1477E+00	.8712E+00	0.	.4446E-03	.2448E-03
24.41	T104	0.	.1030E+00	.7577E+00	0.	.2751E-02	.5540E-02
24.63	HA1	0.	-.1455E+00	.5367E+00	0.	.4064E-02	.1814E-01
24.73	HA1P	0.	-.1803E+00	.5246E+00	0.	.4348E-02	.1846E-01
24.82	HA2	0.	-.4408E+00	.3767E+00	0.	.1379E-01	.3177E-01
24.82	HA2P	0.	-.4617E+00	.2446E+00	0.	.1407E-01	.3222E-01
30.41	HA3	0.	-.1202E+00	.7478E+01	0.	.1914E-01	.4475E-01
31.51	HA3P	0.	-.1430E+00	.6466E+01	0.	.1943E-01	.4547E-01
32.33	HA4	0.	-.1014E+01	-.1464E+00	0.	.2389E-01	.5640E-01
32.45	T201	0.	-.1103E+01	-.2314E+00	0.	.2585E-01	.6111E-01
32.70	T201	0.	-.1236E+01	-.2431E+00	0.	.2333E-01	.5575E-01
33.35	T202	0.	-.1376E+01	-.3274E+00	0.	.1948E-01	.4824E-01
33.45	T202	0.	-.1393E+01	-.3840E+00	0.	.1734E-01	.4334E-01
36.00	T203	0.	-.1202E+01	-.3405E+00	0.	.1921E-01	.4781E-01
34.25	T203	0.	-.1147E+01	-.3244E+00	0.	.1941E-01	.4867E-01
34.40	T204	0.	-.1110E+01	-.3138E+00	0.	.1240E-01	.3432E-01
36.49	HA1	0.	-.4923E+00	-.4474E+00	0.	.5850E-02	.4880E-02
36.79	HA1P	0.	-.4859E+00	-.5047E+00	0.	.6904E-02	.7113E-02
37.50	HA2	0.	-.8700E+00	-.6271E+00	0.	.2554E-01	.4673E-01
38.40	HA2P	0.	-.8636E+00	-.6334E+00	0.	.2654E-01	.4847E-01
41.47	HA3	0.	-.7478E+00	-.7463E+00	0.	.4512E-01	.8850E-01
43.57	HA3P	0.	-.7413E+00	-.7631E+00	0.	.4615E-01	.9004E-01
44.39	HA4	0.	-.6735E+00	-.8873E+00	0.	.4427E-01	.1246E+00
44.79	EPFT10	0.	-.4446E+00	-.1008E+01	0.	.4831E-01	.1705E+00
44.10	RTA1	-.2461E+00	-.8558E-09	-.2020E-08	.4132E-03	-.1837E-09	.3749E-04
47.71	RTA1A	-.4601E+00	-.4706E-09	-.2200E-08	.1378E-03	-.3874E-09	.2023E-06
47.41	RTA1C	-.6872E+00	-.4504E-09	-.2212E-08	.1263E-03	-.3400E-09	.2054E-06
49.30	RTA1C	-.1094E+01	-.2704E-09	-.2383E-08	.5534E-03	-.4360E-06	.2885E-06
49.40	RTA1H	-.1171E+01	-.2644E-09	-.2344E-08	.5424E-03	-.4401E-06	.2936E-06
50.42	RTA1E	-.1535E+01	-.1844E-10	-.2558E-08	.3670E-03	-.5176E-06	.4244E-06
52.06	RTA2	-.1844E+01	.5923E-10	-.2444E-08	.2362E-03	-.2020E-06	.1114E-06
52.44	RTA2	-.2360E+01	.1301E-09	-.3303E-08	.2222E-03	-.1923E-06	.1401E-06
52.70	RTA3	-.3914E+01	.2944E-09	-.5243E-08	.2704E-03	-.1103E-06	.1443E-06
53.40	RTA3	-.4115E+01	.3401E-09	-.5500E-08	.2508E-03	-.7854E-07	.1734E-06
55.67	RTA4	-.2146E+01	.2710E-09	-.2644E-08	.1324E-04	-.2013E-07	.3786E-06
56.17	RTA5	-.2206E+01	.3256E-09	-.2584E-08	.1578E-04	-.1804E-10	.3334E-06
57.96	RTA6	-.4282E+01	.8803E-09	-.4401E-08	.3320E-03	.7463E-07	.1710E-06
58.46	RTA7	-.6042E+01	.1478E-09	-.4444E-08	.3478E-03	.1141E-06	.3524E-06

50.79	DTFA	-.2501E+01	.5242E-09	-.2545E-08	-.2691E-03	.2092E-06	.7406E-06
50.79	QSTR	-.1540E+01	.4616E-09	-.1914E-08	-.2731E-03	.2219E-06	.8183E-06
60.43	DTF7	-.1754E+01	.5257E-09	-.1388E-08	-.3984E-03	.1514E-06	.5333E-06
62.45	RT2A	-.1438E+01	.6119E-09	-.6844E-09	-.5572E-03	-.3472E-06	-.1797E-06
62.55	RT2B	-.1417E+01	.6117E-09	-.6438E-09	-.5782E-03	-.3558E-06	-.1987E-06
64.04	RT2C	-.1107E+01	.7021E-09	-.5429E-10	-.7436E-03	-.5028E-06	-.5017E-06
64.14	RT2D	-.1086E+01	.7019E-09	.9442E-10	-.7547E-03	-.5138E-06	-.5231E-06
65.66	RT2E	-.1770E+01	.7434E-09	.4032E-09	-.9230E-03	-.6978E-06	-.8668E-06
74.6A	DTUNN	.1514E+01	.1461E-08	.5410E-08	-.2144E-02	-.1950E-05	-.2916E-05
74.63	DTUNN	.1500E+01	.1370E-08	.5154E-08	-.2076E-02	-.2074E-05	-.3112E-05
77.1A	DTUNN	.1412E+01	.1255E-08	.5424E-08	-.1907E-02	-.2240E-05	-.3445E-05
77.6A	DTUNN	.1492E+01	.1244E-08	.5436E-08	-.1912E-02	-.2294E-05	-.3400E-05
77.43	DTUNN	.1654E+01	.1356E-08	.5977E-08	-.2085E-02	-.2071E-05	-.3138E-05
78.1A	DTUNN	.1751E+01	.1396E-08	.6207E-08	-.2153E-02	-.1952E-05	-.2948E-05
83.6A	FLONG	.2029E+01	-.6497E-08	-.9410E-08	.6291E-02	.2736E-05	.1978E-05

-----TRAJECTORIES-----

LINE 09 TO CENTER DOUBLE WAIST SECOND ORIGIN -VUGLPUOV02P 08/30/72 14.07.03

7	NAME	T (2.1,6)	Y (2.2,6)	T (3.3,6)	T (3.4,6)	T (4.3,6)	T (4.4,6)
0.00	TIL0	0.	0.	0.	0.	0.	0.
0.3A	FREE	0.	0.	0.	0.	0.	0.
10.0A	CRIFT7	0.	0.	0.	0.	0.	0.
10.73	CONICKER	.1432E-03	.1443E-03	.9322E-05	.9599E-05	.1431E-03	.1444E-03
11.13	CRIFT7A	.2633E-07	-.9300E-05	.3221E-04	.9378E-04	.5722E-03	.6048E-03
11.63	LAFY01	.2434E-03	.2485E-03	.4574E-04	.4881E-04	.2713E-03	.2698E-03
12.3A	DRIFTM	.9254E-02	-.3603E-04	.1250E-03	.1378E-03	.1059E-02	.1185E-02
12.8A	LAMH02	.1550E-02	.1884E-02	.1135E-03	.1228E-03	-.1780E-03	-.1124E-02
20.42	FACCOLL	.1065E-02	.1258E-02	.4743E-03	.5088E-03	.4857E-03	.5132E-03
20.55	SINGORI	.1065E-02	.1258E-02	.4743E-03	.5088E-03	.4857E-03	.5132E-03
20.65	GCOLL	-.2104E-01	-.4430E-01	.5484E-03	.7540E-03	.2193E-01	.4715E-01
20.60	SINGH2	-.2104E-01	-.4430E-01	.9274E-03	.1461E-02	.2193E-01	.4715E-01
22.19	JUNICIN	-.1740E-01	-.3413E-01	.2848E-02	.4293E-02	.1528E-01	.3274E-01
22.26	CRIFT	-.1740E-01	-.3413E-01	.2848E-02	.4293E-02	.1528E-01	.3274E-01
22.4A	TIF1	-.1740E-01	-.3413E-01	.3794E-02	.4184E-02	.2202E-01	.4894E-01
22.13	TIF0	.4388E-01	.1005E+00	.4351E-02	.9297E-02	.2276E-01	.4004E-01
22.23	TIF2	.4388E-01	.1005E+00	.4693E-02	.9910E-02	.2276E-01	.4004E-01
22.7A	TIF2	-.1687E-01	-.3992E-01	.5637E-02	.1194E-01	.1363E-01	.3844E-01
22.93	TIF3	-.1687E-01	-.3992E-01	.5841E-02	.1254E-01	.1363E-01	.3844E-01
24.1A	TIF3	.3602E-01	.8392E-01	.6363E-02	.1376E-01	.2874E-01	.5597E-01
24.41	TIF4	.3602E-01	.8392E-01	.8160E-02	.1720E-01	.2874E-01	.5597E-01
24.63	RA1	.3524E-01	.8294E-01	.1294E-01	.2716E-01	.2856E-01	.5602E-01
24.73	RA1P	.3524E-01	.8294E-01	.1317E-01	.2772E-01	.2856E-01	.5602E-01
24.52	RA2	.3428E-01	.8084E-01	.1788E-01	.3755E-01	.2856E-01	.5602E-01
24.62	RA2P	.3428E-01	.8084E-01	.1815E-01	.3811E-01	.2856E-01	.5602E-01
24.41	RA3	.3252E-01	.7670E-01	.2284E-01	.4794E-01	.2856E-01	.5602E-01
24.51	RA3P	.3250E-01	.7671E-01	.2317E-01	.4850E-01	.2856E-01	.5602E-01
24.33	RA4	.3204E-01	.7131E-01	.2791E-01	.5442E-01	.2856E-01	.5602E-01
24.55	T2P1	.3204E-01	.7131E-01	.2933E-01	.6175E-01	.2846E-01	.5524E-01
24.20	T2P1	-.2330E+00	-.4497E+00	.3344E-01	.6447E-01	.3150E+00	.5122E+00
24.35	T2P2	-.2330E+00	-.4497E+00	.3822E-01	.7634E-01	.3150E+00	.5122E+00
24.45	T2P2	.1244E+00	.2991E+00	.3888E-01	.7592E-01	.3667E+00	.5539E+00
24.00	T2P3	.1244E+00	.2991E+00	.3136E-01	.6795E-01	.3667E+00	.5539E+00
24.25	T2P3	-.1491E+00	-.2290E+00	.2571E-01	.6051E-01	.4305E-01	.7394E-01
24.4A	T2P4	-.1491E+00	-.2290E+00	.1994E-01	.5591E-01	.4305E-01	.7394E-01
24.6A	RA1	-.1484E+00	-.2291E+00	.1431E-02	.4150E-01	.4966E-01	.7834E-01
24.79	RA1P	-.1483E+00	-.2290E+00	.4410E-03	.4072E-01	.4946E-01	.7834E-01
24.5A	RA2	-.1488E+00	-.2271E+00	.1843E-01	.2654E-01	.4946E-01	.7834E-01
24.6A	RA2P	-.1486E+00	-.2270E+00	-.1782E-01	.2581E-01	.4946E-01	.7834E-01
24.67	RA3	-.1472E+00	-.2203E+00	.4784E-01	.1174E-01	.4966E-01	.7834E-01
24.67	RA3P	-.1470E+00	-.2202E+00	.3653E-01	.1094E-01	.4966E-01	.7834E-01
24.34	RA4	-.9674E-01	-.2206E+00	-.5474E-01	-.3287E-02	.4966E-01	.7834E-01
24.20	CRIFT10	-.1307E+00	-.7314E+00	.7314E-01	.1824E-01	.4709E-01	.7811E-01
24.19	RTB1	-.1794E-01	-.3486E-09	-.1445E-09	-.5454E-10	.1743E-09	.1413E-09
47.11	RTB1A	-.2025E-06	-.3553E-06	-.3097E-06	.2284E-06	.4834E-06	.4597E-06
47.41	RTB1B	-.2049E-06	-.3674E-06	-.3495E-06	.2390E-06	.4834E-06	.4517E-06
47.41	RTB1C	-.4057E-06	-.7107E-06	-.8007E-06	.4753E-06	.4834E-06	.4517E-06
47.40	RTB1D	-.4130E-06	-.7230E-06	-.8414E-06	.4858E-06	.4834E-06	.4517E-06
47.42	RTB1E	-.6062E-06	-.1082E-05	-.1464E-06	.7352E-06	.4834E-06	.4517E-06
47.06	RTB2	-.6062E-06	-.1082E-05	-.1774E-06	.7774E-06	.4738E-06	.4711E-06
47.56	G11A	-.9794E-06	-.4497E-06	-.2277E-06	.9533E-06	.1801E-05	.8495E-05
47.39	RTB3	.9794E-06	-.4497E-06	-.3184E-06	.1530E-05	.1801E-05	.8595E-05
47.49	G11A	.3280E-06	-.1147E-05	-.3490E-06	.1551E-05	.1042E-05	-.4537E-05
47.67	RTB4	.3280E-06	-.1147E-05	-.2125E-06	.1837E-06	.1042E-05	-.4537E-05
47.17	G11A	.4405E-06	.2832E-05	-.2148E-06	.7544E-06	.1144E-05	.3334E-05
47.96	RTB5	.4405E-06	.2832E-05	-.4145E-06	.1347E-05	.1144E-05	.3334E-05
48.66	G11A	.1112E-05	.4639E-05	-.4002E-06	.1273E-05	.1854E-05	-.6204E-05
50.79	DTFA	.1112E-05	.4639E-05	-.2457E-06	.7484E-06	.1854E-05	-.6204E-05
50.79	QSTR	-.6216E-06	-.1632E-05	-.1454E-06	.5644E-06	.1940E-05	-.1313E-05
60.43	DTF7	-.6215E-06	-.1632E-05	-.1734E-06	.4154E-06	.1940E-05	-.1313E-05
62.45	RT2A	-.8627E-06	-.1900E-05	-.2492E-06	.1255E-06	-.1714E-06	-.2114E-05
62.55	RT2B	-.8712E-06	-.1909E-05	-.2521E-06	.1530E-06	-.1714E-06	-.2114E-05
64.04	RT2C	-.1045E-05	-.2145E-05	-.3015E-06	.6285E-06	-.1714E-06	-.2114E-05
64.14	RT2D	-.1104E-05	-.2193E-05	-.3030E-06	.6541E-06	-.1714E-06	-.2114E-05
64.66	RT2E	-.1316E-05	-.2302E-05	-.3781E-06	.1078E-05	-.1714E-06	-.2114E-05
74.6A	DTUNN	-.1316E-05	-.2302E-05	.6530E-06	.1095E-05	.7093E-06	-.1552E-07
74.63	DTUNN	-.8669E-05	-.1338E-04	.4503E-06	.1046E-05	.9682E-06	.3958E-05
77.1A	DTUNN	-.8669E-05	-.1338E-04	.4261E-06	.9466E-06	.9682E-06	.3958E-05
77.43	DTUNN	.8726E-05	.1295E-04	.4550E-06	.9160E-06	.2181E-05	-.2697E-05
77.93	DTUNN	.8726E-05	.1295E-04	.5101E-06	.9834E-06	.2181E-05	-.2697E-05
78.1A	DTUNN	.8447E-06	.8411E-06	.5388E-06	.1302E-05	.9250E-07	.1257E-05
83.6A	FLONG	.8447E-06	.8411E-06	.1052E-05	.5974E-05	.9250E-07	.1257E-05

TRANSPORT. Beam Line DO

- a) from accelerator end to the double waist in the beam transfer tunnel, by R-matrix data entries (14 types)
- b) from the double waist in beam transfer tunnel to Target Station 1.

1.00000	.24900	.10100	.34700	.29300	1.00000	.35000	1.44000	HPBUS
12.00000	.52300	0.00000	0.00000	0.00000	0.00000	1.19000	0.00000	
1.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	ENDACC
14.00000	.77400	-1.94300	0.00000	0.00000	0.00000	-0.00000	1.00000	R1
14.00000	.52400	-0.02900	0.00000	0.00000	0.00000	-0.00000	0.00000	R2
14.00000	0.00000	0.00000	-0.68900	2.40100	0.00000	-0.16300	3.00000	R3
14.00000	0.00000	0.00000	-0.39500	-0.07500	0.00000	-0.02000	4.00000	R4
14.00000	-0.30000	-0.00000	.00500	.00600	1.00000	-2.19400	5.00000	R5
14.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000	6.00000	R6
14.00000	4.00000	3.00000						GAPS
1.00000	41.70000							DSTUNW
5.00000	.12500	2.04700	4.00000					Q4TUNW
5.00000	.12500	2.04700	4.00000					Q4TUNW
1.00000	.25000							DATUNW
5.00000	.25000	-2.03400	4.00000					Q5TUNW
5.00000	.25000	-2.03400	4.00000					Q5TUNW
1.00000	.25000							D7TUNW
5.00000	.12500	1.52700	4.00000					Q7TUNW
5.00000	.12500	1.52700	4.00000					Q7TUNW
1.00000	11.50000							DATUNW
4.00000	1.55400	-16.00000	0.00000					BE
2.00000	0.00000							FF2
1.00000	.50000							L8
5.00000	.10500	-6.78000	4.00000					Q1
5.00000	.10500	-6.78000	4.00000					Q1
1.00000	.15000							L9
5.00000	.10500	8.26900	4.00000					Q2
5.00000	.10500	8.26900	4.00000					Q2
1.00000	20.63000							L1
5.00000	.10500	.52300	4.00000					QADAP1
5.00000	.10500	.52300	4.00000					QADAP1
1.00000	.15000							FREE2
5.00000	.10500	1.52900	4.00000					QADAP2
5.00000	.10500	1.52900	4.00000					QADAP2
20.00000	90.00000							ROT1
1.00000	.25000							L2
2.00000	0.00000							FF3
4.00000	1.57700	16.00000	0.00000					RF1
1.00000	.27000							L3
5.00000	.10500	8.59700	4.00000					QAG1
5.00000	.10500	8.59700	4.00000					QAG1
1.00000	.25000							L4
4.00000	1.55400	16.00000	0.00000					RF2
1.00000	.25000							L5
5.00000	.10500	-5.53000	4.00000					QAG3
5.00000	.10500	-5.53000	4.00000					QAG3
1.00000	.25000							L6
4.00000	1.57700	16.00000	0.00000					RF3
2.00000	0.00000							FF4
1.00000	.25000							L7
5.00000	.10500	5.27400	4.00000					QAG4
5.00000	.10500	5.27400	4.00000					QAG4
1.00000	.25000							SHIELD
0.00000	-90.00000							ROT2

*PIUS
*BFAN# 1.003000 1.45 GEV/C

0.000 M	0.	.3990	CN				
	0.	.3010	NR	.5200			
	0.	.3470	CN	0.	0.		
	0.	.2930	NR	0.	0.	.1940	
	0.	1.800	CN	0.	0.	0.	0.
	0.	.3500	PC	0.	0.	0.	0.

*R1	*			
MATRIX		14.0	ROW	1
*R2	*			
MATRIX		14.0	ROW	2
*R3	*			
MATRIX		14.0	ROW	3
*R4	*			
MATRIX		14.0	ROW	4

0.000 M 0.4999 0.0000

- TRAJECTORIES-

END TO TARIFF 1--PICK UP PRODUCT 7/31/72, 90 DEG PRODUCT 10/04/72 14.27.48
DECK

[illegible]

TRAJECTORIES

000 TO TARIFF 1--PICK UP PRODUCT 7/31/72, 00 DEG PRODUCT 10/04/72 14.27.48

	7	NAME	R (1.1)	R (1.2)	R (2.1)	R (2.2)	R (3.3)	R (3.4)
	6.00	ENDACC	-.1930F+01	0.	0.	-.1000E+01	-.1800E+01	0.
	61.00	0477000	-.3943F+01	-.2720F+01	-.5240E+00	-.2900E-01	-.3094F+01	-.1943F+01
	61.12	0477000	-.3904E+01	-.2904E+01	-.6474E-01	.7819E+01	-.3194E+01	-.1965E+01
	61.25	0477000	-.3774E+01	-.2724F+01	-.1372E+02	.7619E+01	-.3251E+01	-.2031F+01
	61.50	0477000	-.3439E+01	-.1834E+01	-.1372E+02	.7619E+01	-.3550F+01	-.2710F+01
	61.75	0477000	-.3199F+01	-.1701E+01	-.5117F+01	.3034E+01	-.3740E+01	-.2315F+01
	62.00	0477000	-.3175E+01	-.1640E+01	.3151E+01	-.1357E+01	-.3444E+01	-.2270F+01
	62.25	0477000	-.3154E+01	-.1714E+01	.3151E+01	-.1357E+01	-.3445F+01	-.2150F+01
	62.37	0477000	-.3274E+01	-.1721F+01	-.6077E-01	.3272F+00	-.3415E+01	-.2103E+01
	62.50	0477000	-.3253F+01	-.1704E+01	-.3237E+01	.2003E+01	-.3347F+01	-.2082F+01
	72.52	0477000	-.3171E+03	.5018E+00	-.3237E+01	.2003E+01	-.2700E+01	-.1335F+01
	75.48	RF	-.3521F+00	.7343E+00	-.2325E+01	.9441E+00	-.2621F+01	-.1234F+01
	75.54	L4	-.3846E+00	.7834E+00	-.2325E+01	.9441F+00	-.2640E+01	-.1299F+01
	75.64	01	-.3804F+00	.8047F+00	-.5555E+01	.3839E+01	-.2547E+01	-.1189F+01
	75.79	01	-.3804F+00	.8047E+00	-.5555E+01	.3839E+01	-.2704F+01	-.1106F+01
	75.94	L4	-.1121F+01	.9473E+00	-.3844E+01	.6874E+01	-.2111F+01	.9601F+00
	76.04	02	-.1104F+01	.1017F+01	-.3844E+01	.2449F+01	-.1943F+01	.8953F+00
	76.15	02	-.1201F+01	.1019E+01	-.1445E+01	-.2093E+01	-.1905F+01	.8435E+00
	76.79	L1	-.1453F+01	-.1460E+01	.1445E+01	-.2093E+01	.7017F+00	-.1401F+01
	96.44	060401	-.3147E+01	-.3317F+01	.4544E+00	-.1143E+01	.7140F+00	-.1415F+01
	96.74	060401	-.1447E+01	-.3324F+01	.4310E+00	-.2244E+00	.7244F+00	-.1433F+01
	97.14	FWF02	-.1409F+01	-.3324F+01	.4310E+00	-.2244F+00	.7574F+00	-.1461E+01
	97.24	040402	-.1444F+01	-.3314F+01	-.1121E+01	.2503F+01	.7742F+00	-.1447F+01
	97.35	040402	-.1944F+01	-.2775E+01	-.2644F+01	.5213E+01	.8057E+00	-.1524E+01
	97.60	L2	.3220F+04	-.6445F+04	.6474E+04	.9357F+04	.5478F+04	.6434E+04
	97.80	RF	-.3444E+04	-.3444E+04	-.3444E+04	.1727E+07	.1727E+04	-.4212E+04

99.45	L7	.1837E-04	-.7030E-04	-.9386E-04	.1727E-07	.2568E-04	-.4396E-04
99.75	QAG3	.1641E-04	-.2777E-04	-.1756E-07	.3074E-07	.2647E-04	-.4587E-04
99.66	QAG1	.1467E-04	-.2789E-04	-.2489E-07	.4273E-07	.2977E-04	-.5001E-04
99.01	L4	.8450E-09	-.1121E-04	-.2489E-07	.4273E-07	.3697E-04	-.6267E-04
91.46	RF2	-.2970E-04	.5211E-04	-.2307E-07	.3941E-07	.8475E-04	-.1415E-07
91.71	L5	-.7546E-04	.8197E-04	-.2307E-07	.3941E-07	.9185E-04	-.1541E-07
91.82	QAG3	-.2945E-04	.6709E-04	-.3403E-07	.5454E-07	.9759E-04	-.1570E-07
91.92	QAG1	-.4245E-04	.7472E-04	-.4606E-07	.7951E-07	.9247E-04	-.1550E-07
92.17	L6	-.5416E-04	.9420E-04	-.4606E-07	.7951E-07	.8618E-04	-.1445E-07
93.75	RF3	-.1165E-07	.2918E-07	-.3127E-07	.5387E-07	.4690E-04	-.7787E-04
94.00	L7	-.1246E-07	.2153E-07	-.3127E-07	.5387E-07	.4061E-04	-.6740E-04
94.10	QAG4	-.1258E-07	.2177E-07	.4274E-04	-.7653E-04	.3840E-04	-.6398E-04
94.21	QAG4	-.1275E-07	.2137E-07	.3969E-07	-.6845E-07	.3775E-04	-.6247E-04
97.33	SHIELD	.1727E-10	-.1460E-09	.1964E-07	-.6845E-07	.2908E-04	-.4546E-04

-----TRAJECTORIES-----

POO TO TARGET 1--PICK UP POOVOCY 7/31/77. 90 DEG POOVUOR 10/04/77 14.27.48

Z	NAME	P(4.3)	P(4.4)	R(1.6)	P(1.3)	R(1.4)	R(2.3)
0.00	ENDACC	0.	.1000E+01	0.	0.	0.	0.
61.00	OSTURN	-.7950E+00	-.7500E-01	0.	0.	0.	0.
61.12	OSTURN	-.8096E+01	.3497E+01	0.	0.	0.	0.
61.25	OSTURN	-.1194E+02	.7150E+01	0.	0.	0.	0.
61.50	OSTURN	-.1194E+02	.7150E+01	0.	0.	0.	0.
61.75	OSTURN	-.2791E+01	.1216E+01	0.	0.	0.	0.
62.00	OSTURN	.7310E+01	-.4797E+01	0.	0.	0.	0.
62.25	OSTURN	.7310E+01	-.4797E+01	0.	0.	0.	0.
62.77	OSTURN	.3942E+01	-.2721E+01	0.	0.	0.	0.
62.50	OSTURN	.6224E+00	-.6780E+00	0.	0.	0.	0.
73.52	OSTURN	.6224E+00	-.6780E+00	0.	0.	0.	0.
75.04	RF	.5124E+00	-.6236E+00	-.3881E+00	0.	0.	0.
75.59	L4	.4055E+00	-.5731E+00	-.6321E+00	0.	0.	0.
75.68	Q1	.4815E+01	-.4490E+01	-.6958E+00	0.	0.	0.
75.79	Q1	.1885E+02	-.9115E+01	-.7882E+00	0.	0.	0.
75.94	L9	.1885E+02	-.9115E+01	-.9380E+00	0.	0.	0.
76.04	Q2	.9824E+01	-.4402E+01	-.1018E+01	0.	0.	0.
76.15	Q2	.1264E+01	-.1048E+01	-.1051E+01	0.	0.	0.
96.78	L1	.1264E+01	-.1048E+01	-.3121E+01	0.	0.	0.
96.88	QANAD1	.1467E+01	-.1493E+01	-.3127E+01	0.	0.	0.
96.00	QANAD1	.1666E+01	-.1494E+01	-.3124E+01	0.	0.	0.
97.14	RF2	.1666E+01	-.1494E+01	-.3112E+01	0.	0.	0.
97.24	QANAD2	.2207E+01	-.3104E+01	-.3091E+01	0.	0.	0.
97.35	QANAD2	.2947E+01	-.4742E+01	-.3047E+01	0.	0.	0.
97.40	L2	.5290E-08	-.7743E-08	.1757E+00	.8794E+00	-.1635E+01	.2947E+01
99.18	RF1	.5355E-04	-.7613E-08	.5765E+00	.1209E+01	-.2074E+01	.1139E+01
99.45	L3	.5355E-04	-.7613E-08	.7133E+00	.1240E+01	-.2106E+01	.1139E+01
99.55	QAG1	.1745E-07	-.2854E-07	.7484E+00	.1222E+01	-.2067E+01	.4572E+01
99.66	QAG1	.1339E-07	-.5885E-07	.7482E+00	.1145E+01	-.1928E+01	.1006E+02
99.01	L4	.1670E-07	-.5885E-07	.7032E+00	.4930E+00	-.1483E+01	.1006E+02
91.46	RF2	.1339E-07	-.5885E-07	.7340E+00	-.7192E+00	.1341E+01	-.1071E+02
91.71	L5	.1670E-07	-.5885E-07	.7887E+00	-.9744E+00	.1809E+01	-.1021E+02
91.82	QAG3	.2755E-04	-.4274E-04	.8241E+00	-.1097E+01	.2027E+01	-.1724E+02
91.92	QAG3	-.2497E-07	.4223E-07	.8853E+00	-.1255E+01	.2308E+01	-.1677E+02
92.17	L6	-.2497E-07	.4223E-07	.1067E+01	-.1674E+01	.3059E+01	-.1677E+02
93.75	RF3	-.2497E-07	.4223E-07	.2395E+01	-.3984E+01	.7189E+01	-.1187E+02
94.00	L7	-.2477E-07	.4191E-07	.2630E+01	-.4281E+01	.7710E+01	-.1187E+02
94.10	QAG4	-.1357E-07	.2137E-07	.2640E+01	-.4341E+01	.7825E+01	.3841E+00
94.21	QAG4	-.2779E-04	.5453E-04	.2669E+01	-.4273E+01	.7649E+01	.1263E+02
97.33	SHIELD	-.2779E-04	.5453E-04	.8681E+00	-.3339E+00	.5286E+00	.1263E+02

-----TRAJECTORIES-----

POO TO TARGET 1--PICK UP POOVOCY 7/31/77. 90 DEG POOVUOR 10/04/77 14.27.48

Z	NAME	P(2.4)	P(3.1)	R(3.2)	P(4.1)	R(4.2)	R(3.6)
0.00	ENDACC	0.	0.	0.	0.	0.	0.
61.00	OSTURN	0.	0.	0.	0.	0.	-.2850E+00
61.12	OSTURN	0.	0.	0.	0.	0.	-.2885E+00
61.25	OSTURN	0.	0.	0.	0.	0.	-.2987E+00
61.50	OSTURN	0.	0.	0.	0.	0.	-.3257E+00
61.75	OSTURN	0.	0.	0.	0.	0.	-.3418E+00
62.00	OSTURN	0.	0.	0.	0.	0.	-.3358E+00
62.25	OSTURN	0.	0.	0.	0.	0.	-.3188E+00
62.77	OSTURN	0.	0.	0.	0.	0.	-.3122E+00
62.50	OSTURN	0.	0.	0.	0.	0.	-.3094E+00
73.52	OSTURN	0.	0.	0.	0.	0.	-.2307E+00
75.04	RF	0.	0.	0.	0.	0.	-.2205E+00
75.59	L4	0.	0.	0.	0.	0.	-.2174E+00
75.68	Q1	0.	0.	0.	0.	0.	-.2131E+00
75.79	Q1	0.	0.	0.	0.	0.	-.2003E+00
75.94	L9	0.	0.	0.	0.	0.	-.1763E+00
76.04	Q2	0.	0.	0.	0.	0.	-.1636E+00
76.15	Q2	0.	0.	0.	0.	0.	-.1584E+00
96.78	L1	0.	0.	0.	0.	0.	.1172E+00
96.88	QANAD1	0.	0.	0.	0.	0.	.1147E+00
96.00	QANAD1	0.	0.	0.	0.	0.	.1166E+00
97.14	RF2	0.	0.	0.	0.	0.	.1196E+00
97.24	QANAD2	0.	0.	0.	0.	0.	.1221E+00
97.35	QANAD2	0.	0.	0.	0.	0.	.1258E+00
97.40	L2	-.4362E+01	-.1799E+01	.3145E+01	.2664E+01	-.5213E+01	.2897E+01

99.14	RF1	-.1124E+01	-.1791E+01	.2747E+01	.2591E+01	-.5085E+01	.1997E+01
99.65	L7	-.1124E+01	-.1721E+01	.2205E+01	.2591E+01	-.5085E+01	.1842E+01
99.55	QAG1	.8555E+01	-.1725E+01	.2205E+01	-.3493E+01	.5066E+01	.1827E+01
99.66	QAG1	.1782E+02	-.1745E+01	.2713E+01	-.9758E+01	.1546E+02	.1900E+01
99.01	L6	.1782E+02	-.1639E+01	.2699E+01	-.9758E+01	.1546E+02	.2183E+01
91.66	RF2	.1793E+02	-.3157E+01	.5105E+01	-.9758E+01	.1546E+02	.3943E+01
91.71	L5	.1743E+02	-.3401E+01	.5492E+01	-.9758E+01	.1546E+02	.4226E+01
91.82	QAG1	.2761E+02	-.3650E+01	.5548E+01	.4509E+00	-.1018E+01	.4278E+01
91.92	QAG1	.1794E+02	-.3791E+01	.5471E+01	.1065E+02	-.1747E+02	.4197E+01
92.17	L6	.1794E+02	-.3125E+01	.5034E+01	.1065E+02	-.1747E+02	.3848E+01
93.75	RF7	.2117E+02	-.1246E+01	.2279E+01	.1065E+02	-.1747E+02	.1641E+01
94.90	L7	.2117E+02	-.1181E+01	.1864E+01	.1059E+02	-.1737E+02	.1292E+01
94.19	QAG4	-.9224E+00	-.1887E+01	.1689E+01	.7379E+01	-.1238E+02	.1165E+01
94.21	QAG4	-.2298E+02	-.1926E+01	.1543E+01	.4391E+01	-.7753E+01	.1072E+01
97.33	SHIELD	-.2298E+02	.3643E+00	-.8358E+00	.4391E+01	-.7753E+01	-.1202E+01

APPENDIX IV

Aberrations Calculations with HIGHORD of Beam Line DO from Accelerator end to Target Station 1, assuming symmetry about the horizontal plane, for aberrations at Target 1.

Case	Quad gradient (T/m)	A _x (cm)	A _x (mr)	A _y (cm)	A _y (mr)
a)	10	0.1	0.03	0.09	0.2
b)	10	0.1	0.6	0.09	1.0
c)	5	0.1	0.6	0.09	1.0
d)	5	0.2	0.6	0.2	1.0

Case a

\$DIST

IMAX = 26.

DL = 0.1E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.5E+00, 0.5E+00,
0.5E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.21E+00, 0.21E+00,
0.21E+00, 0.21E+00, 0.21E+00, 0.21E+00, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
0.0, 0.0, 0.0, 0.0, 0.0.

ISROT1 = 0.

ISROT2 = 23.

IENDRT1 = 15.

IENDRT2 = 27.

IMOR = 1.

IVERT = 0.

SEND

\$PHASE

X0 = 0.389E+00.

Y0 = 0.347E+00.

XP0 = 0.301E+00.

YP0 = 0.293E+00.

DO = 0.35E+00.

SEND

\$ABBERTN

AX0 = 0.1E+00.

AXP0 = 0.3E+01.

AY0 = 0.9E+01.

AYP0 = 3.2E+00.

GN = 0.1E+02.

P0 = 0.146E+01.

SEND

LINE DU FROM ACCELERATOR END TO TARGET STATION 1

1	2	1.00181	2.06775	1.21190	3.50152	1.04614	.93726	1.98372	-1.20494	-1.48547	1.00202	.99799
2	2	1.46136	3.24758	-1.06211	-1.68157	2.18652	.38837	1.08227	-1.54513	-1.70996	.99192	1.00816
3	2	1.33290	2.99858	-.74881	-.91946	2.14908	.32662	1.04324	-1.60128	-2.11246	1.01983	.98056
4	2	1.33308	3.15147	-.32336	-.01964	2.39968	.21958	.85960	-1.89550	-2.82903	.99190	1.00816
5	2	-1.30126	-2.38492	1.46057	1.41931	2.67382	-1.15318	-.25389	-5.31890	-2.05069	.98580	1.01440
6	2	-1.14554	-2.14202	-1.12873	-3.02979	2.16482	-1.46093	-.36476	-.32383	-.73091	1.05297	.94969
7	2	-1.41990	-2.70336	-3.45418	-7.27072	2.46862	-1.18708	-.33043	4.99885	.42559	.98580	1.01442
8	4	.07075	-1.30171	.47534	4.93778	1.25044	1.69028	2.03702	8.05705	10.32098	.96809	1.03292
9	4	.10630	-.07748	.54610	9.29204	.53573	3.36826	4.13863	3.01519	3.99302	1.03008	.97084
10	4	.28776	1.87266	-.62622	-.75150	-.03856	1.65539	2.10354	-.18654	.39456	.95644	1.04554
11	4	-.14356	-.42532	-2.70835	-11.88695	-.52538	3.28471	4.31545	-3.11065	-3.79120	1.03004	.97086
12	4	-.54324	-2.09851	-1.17031	-5.77167	-1.18039	1.62475	2.17547	-8.10569	-10.21737	.96811	1.03296
13	4	1.49569	2.73711	3.95131	7.90463	-.04757	-1.96943	-1.52061	1.59747	.72955	1.00773	.99236
14	4	1.78444	3.30567	.17243	.86291	-.05879	-1.78253	-1.40917	-1.30997	-1.61408	.96978	1.03114
15	4	1.51887	2.84769	-3.37341	-5.66183	-.05175	-2.13155	-1.72135	-3.73204	-3.47914	1.00826	.99182
16	2	1.88763	-2.08720	-6.64509	3.82287	.00000	-3.14969	1.97155	-6.41680	3.50912	.99314	1.00774
17	2	1.23293	-1.71028	-5.17055	3.06582	.00000	-3.68823	2.28923	-2.36396	1.20216	1.02270	.97856
18	2	1.26510	-1.71652	-.04067	.32639	.00000	-3.42074	2.10673	3.94891	-2.72533	.99665	1.00414
19	2	-.91509	.81354	-5.58848	3.86159	-.70000	-2.52941	1.17202	9.74846	-4.90707	1.01357	.98738
20	2	-1.17879	1.00884	-3.81466	2.42949	-1.00999	-1.97748	.90199	9.89923	-5.02861	.98529	1.01571
21	2	1.87392	-3.31387	.95858	-1.16208	-3.12434	.71607	-1.41487	1.46287	-1.49360	.99975	1.00105
22	2	1.48227	-3.30957	-1.11944	2.49801	-3.08549	.77902	-1.48869	2.29929	-3.10746	.99785	1.00294
23	4	1.21134	-2.04979	-4.53315	8.48258	.74249	1.33553	-2.22231	3.92511	-5.10485	.98406	1.01706
24	4	-1.10270	2.03630	-13.34498	23.72796	.82806	3.43046	-5.53671	-.44841	1.01219	1.01056	.99039
25	4	-4.31807	7.78311	.38201	-.91768	2.67508	1.09227	-1.69623	-7.41225	12.43532	.99021	1.01073
26	4	-.33375	.52879	12.62059	-22.97481	.86782	-.34416	.83550	-4.38934	7.75015	.99996	1.00075

NN = 0 ICONT = 0 PHASE SPACE X, XP, Y, YP, FOR K(INN) = 1 0. 0. 0. 0.

0 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 C(1) = 0.
=====

21

LINE 00 FROM ACCELERATOR END TO TARGET STATION 1

HORIZONTAL PLANE

TABLE FOR ABBERATIONS AX0= .1000 AXP0= .0300 AY0= .0900 AYP0= .2000 FOR N POLEPAIRS = 2							
NN	EPSILON = PERMISSIBLE ERROR / APERTURE RADIUS A			POLEFACE MODIFICATION BY 1 RUMP			
	ERROR EXCITATION 1 POLE ONLY	DISPLACEMENT OF 1 POLE ONLY		EPS = H * DPHI / A (RAD)			
		RADIAL	AZIMUTHAL	PHI = 45 DEG	55 DEG	65 DEG	75 DEG
1	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
2	4.07E-05	-2.22E-05	2.20E-05	1.00E+03	1.00E+03	1.00E+03	1.00E+03
3	1.00E+03	-1.33E-05	3.94E-06	1.00E+03	1.00E+03	1.00E+03	1.00E+03
4	-1.45E-04	-2.96E-05	2.96E-05	1.00E+03	1.00E+03	1.00E+03	1.00E+03
5	1.00E+03	-1.56E-06	2.35E-06	5.03E-07	3.52E-06	-1.01E-06	-3.52E-06
WHERE A = APERTURE RADIUS. H = HEIGHT OF STEEL ADDED OVER DIFFERENTIAL RANGE DPHI. PHI = ANGLE μ RESPECT TO NEUTRAL POTENTIAL AXIS NN=1 = QUADRUPOLE. NN=5 = OCTUPOLE							

SDIST

IMAX = 26.

Case b

DL = 0.1E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.5E+00, 0.5E+00,
 0.5E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.21E+00, 0.21E+00,
 0.21E+00, 0.21E+00, 0.21E+00, 0.21E+00, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
 0.0, 0.0, 0.0, 0.0, 0.0

ISROT1 = 8.

ISROT2 = 23.

TENDRT1 = 15.

TENDRT2 = 27.

IMOP = 1.

IVEROT = 0.

SFND

LINE 00 FROM ACCELERATION END TO TARGET STATION 1

0 1.00000E+03 0 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 0. 0. 0. C(1) = 0. *****

1 1.00000E+03 0 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 0. 0. 0. C(2) = 2.442E+07 *****

2 1.00000E+03 156 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 5.2984E+05 -2.2912E+07 3.4289E+05 4.5855E+06 C(3) = 8.526E-04 *****

3 2.70058E-08 3.70481E-09 2.28008E-09 2.55220E-09 2.28008E-09 C(4) = 8.351E-05 *****

4 8.4946E-08 1.21387E-08 1.29149E-08 1.31608E-08 1.21387E-08 C(5) = 4.742E-04 *****

5 4.28427E-09 4.99652E-10 6.49835E-11 7.20557E-11 6.49835E-11 C(6) = 2.644E-06 *****

NN = 5 ICONT = 400 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 -2.3341E+07 1.2008E+09 1.3850E+09 1.3878E+10

5ABBERTN
AX0 = 0.1E+00
AXP0 = 0.6E+00
AY0 = 0.9E+01
AYP0 = 0.1E+01
GX = 0.1E+02
P0 = 0.1464E+01
SEND

1PMASE
X0 = 0.399E+00
Y0 = 0.347E+00
XP0 = 0.301E+00
YP0 = 0.291E+00
G0 = 0.35E+00
SEND

LINE 00 FROM ACCELERATOR END TO TARGET STATION 1

HORIZONTAL PLANE

TABLE FOR ABBERATIONS AX0= .1000 AXP0= .6000 AY0= .0900 AYP0= 1.0000							
FOR N POLEPAIRS = 2							
NN	EPSILON = PERMISSIBLE ERROR / APERTURE RADIUS A			POLEFACE MODIFICATION BY 1 BUMP			
	ERROR EXCITATION 1 POLE ONLY	DISPLACEMENT OF 1 POLE ONLY		EPS = H * DPHI / A (RAD)			
		RADIAL	AZIMUTHAL				
				PHI = 45 DEG	55 DEG	65 DEG	75 DEG
1	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
2	8.15E-04	-6.44E-04	4.41E-04	1.00E+03	1.00E+03	1.00E+03	1.00E+03
3	1.00E+03	-1.64E-04	4.84E-05	1.00E+03	1.00E+03	1.00E+03	1.00E+03
4	-2.89E-03	-5.93E-04	5.93E-04	1.00E+03	1.00E+03	1.00E+03	1.00E+03
5	1.00E+03	-7.05E-06	1.06E-05	2.27E-06	1.59E-05	-4.53E-06	-1.59E-05

WHERE A = APERTURE RADIUS.

H = HEIGHT OF STEEL ADDED OVER DIFFERENTIAL RANGE DPHI.

PHI = ANGLE θ / RESPECT TO NEUTRAL POTENTIAL AXIS

NN=1 = QUADRUPOLE. NN=5 = OCTUPOLE

\$D1ST

Case c

INAX = 26.

OL = 0.1E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.5E+00, 0.5E+00, 0.5E+00, 0.21E+00, 0.21E+00,
0.5E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.21E+00, 0.21E+00,
0.21E+00, 0.21E+00, 0.21E+00, 0.21E+00, 0.21E+00, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
0.0,
0.0,
0.0, 0.0, 0.0, 0.0, 0.0

ISROT1 = 8.

ISROT2 = 23.

IENDRT1 = 15.

IENDRT2 = 27.

IMOR = 1.

IVERT = 0.

\$END

\$PHASE

X0 = 0.389E+00.

Y0 = 0.347E+00.

XP0 = 0.301E+00.

YP0 = 0.293E+00.

D0 = 0.35E+00.

\$END

\$ABRERTH

AX0 = 0.1E+00.

AXP0 = 0.6E+00.

AY0 = 0.9E+01.

AYP0 = 0.1E+01.

GN = 0.5E+01.

P0 = 0.1464E+01.

\$END

LINE DO FROM ACCELERATION END TO TARGET STATION 1

0 NN = 0 ICONT = 0 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 0. 0. 0. 0.
0 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 C(1) = 0.

1 NN = 1 ICONT = 0 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 0. 0. 0. 0.
1 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 C(2) = 2.442E+07

2 NN = 2 ICONT = 156 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 5.2984E+05 -2.2912E+07 3.4289E+05 4.5875E+06
2 1.88736E+07 2.61874E+08 2.62472E+07 2.18077E+07 2.61874E+08 C(3) = 8.526E-04

3 NN = 3 ICONT = 364 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 3.7029E+06 -1.6178E+08 -3.9472E+07 -3.9182E+08
3 2.70058E+08 3.70881E+09 2.28004E+09 2.55220E+09 2.28008E+09 C(4) = 8.351E-05

4 NN = 4 ICONT = 832 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 1.1767E+06 -4.9429E+07 6.9687E+06 7.5987E+07
4 8.49840E+08 1.21387E+09 1.29149E+08 1.31608E+08 1.21387E+08 C(5) = 4.742E-04

5

NN = 5 ICONF = *08 PHASE SPACE X, XP, Y, YP, FOR K(INN) = 1 = -2.3341E+07 1.2008E+09 1.3850E+09 1.3878E+10
 5 4.26427E-04 4.99652E-10 6.49635E-11 7.20557E-11 6.49835E-11 C(6) = 2.644E-06
 =====

LINE DO FROM ACCELERATOR END TO TARGET STATION)

H O R I Z O N T A L P L A N E

TABLE FOR ABBERATIONS AX0= .1000 AXP0= .6000 AY0= .0900 AYP0= 1.0000
 FOR N POLEPAIRS = 2

EPSILON = PERMISSIBLE ERROR / APERTURE RADIUS A

POLEFACE MODIFICATION BY 1 RUMP

ERROR FACITATION

DISPLACEMENT OF 1 POLE ONLY

NN.	1 POLE ONL.	RADIAL	AZIMUTHAL	EPS = H * DPHI / A (RAD)			
				PHI = 45 DEG	55 DEG	65 DEG	75 DEG
1	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
2	1.63E-03	-8.88E-04	8.82E-04	1.00E+03	1.00E+03	1.00E+03	1.00E+03
3	1.00E+03	-3.27E-04	9.68E-05	1.00E+03	1.00E+03	1.00E+03	1.00E+03
4	-5.74E-03	-1.19E-03	1.19E-03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
5	1.00E+03	-1.41E-05	2.12E-05	4.53E-06	3.17E-05	-9.07E-06	-3.17E-05

WHERE A = APERTURE RADIUS.

H = HEIGHT OF STEEL ADDED OVER DIFFERENTIAL RANGE DPHI.

PHI = ANGLE W/ RESPECT TO NEUTRAL POTENTIAL AXES

NN=1 = QUADRUPOLE, NN=5 = OCTUPOLE

\$DIST

Case d

IMAX = 26.

DL = 0.1E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.5E+00, 0.5E+00,
 0.5E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.21E+00, 0.21E+00,
 0.21E+00, 0.21E+00, 0.21E+00, 0.21E+00, 0.21E+00, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
 0.0,
 0.0,

ISROT1 = 8.

\$PHASE

\$ABBERTN

ISROT2 = 23.

X0

= 0.389E+00.

AX0 = 0.2E+00.

IENDPT1 = 15.

Y0

= 0.347E+00.

AXP0 = 0.6E+00.

IENDPT2 = 27.

XP0

= 0.301E+00.

AY0 = 0.2E+00.

IMOR = 1.

YP0

= 0.293E+00.

AYP0 = 0.1E+01.

IVERT = 0.

D0

= 0.35E+00.

GN = 0.5E+01.

\$END

\$END

P0 = 0.146E+01.

\$END

LINE 00 FROM ACCELERATOR END TO TARGET STATION 1

0
NN = 0 ICONT = 0 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 0. 0. 0. 0.
0 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 C(1) = 0.

1
NN = 1 ICONT = 0 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 0. 0. 0. 0.
1 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 C(2) = 2.442E+07

2
NN = 2 ICONT = 156 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 5.2984E+05 -2.2912E+07 3.4289E+05 4.5855E+06
2 3.77472E-07 2.61874E-08 5.83271E-07 2.18077E-07 2.61874E-08 C(3) = 8.526E-04

3
NN = 3 ICONT = 364 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 3.7029E+06 -1.6178E+08 -5.9472E+07 -3.9182E+08
3 5.40115E-08 3.70881E-09 5.06686E-09 2.55220E-09 2.55220E-09 C(4) = 9.348E-05

4
NN = 4 ICONT = 832 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 1.1767E+06 -4.9429E+07 6.9687E+06 7.5903E+07
4 1.4946E-07 1.21387E-08 2.86997E-08 1.31608E-08 1.21387E-08 C(5) = 4.742E-04

5
NN = 5 ICONT = 108 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * -2.3341E+07 1.2008E+09 1.3856E+09 1.3670E+10
5 8.56453E-09 4.99652E-10 1.44408E-10 7.20557E-11 7.20557E-11 C(6) = 2.932E-06

LINE ON FROM ACCELERATOR END TO TARGET STATION 1
HORIZONTAL PLANE

APPENDIX V

Aberrations Calculations with HIGHERD of beam: line DO from accelerator end to Target Station 1, assuming symmetry about the vertical plane, for aberrations at Target 1.

Case	Quad gradient (T/m)	A_x (cm)	A_x (μ r)	A_y (cm)	A_y (μ r)
a)	10	0.1	0.03	0.09	0.2
b)	10	0.1	0.6	0.09	1.0
c)	5	0.1	0.6	0.09	1.0
d)	5	0.2	0.6	0.2	1.0

Case 2

IMAY = 240

0.1E+00.	0.25E+00.	0.5E+00.	0.25E+00.	0.25E+00.	0.5E+00.	0.25E+00.	0.5E+00.	0.5E+00.	0.5E+00.	0.5E+00.
0.5E+00.	0.5E+00.	0.25E+00.	0.5E+00.	0.25E+00.	0.25E+00.	0.25E+00.	0.5E+00.	0.25E+00.	0.21E+00.	0.21E+00.
0.21E+00.	0.21E+00.	0.21E+00.	0.21E+00.	0.21E+00.	0.21E+00.	0.0.	0.0.	0.0.	0.0.	0.0.
0.0.	0.0.	0.0.	0.0.	0.0.	0.0.	0.0.	0.0.	0.0.	0.0.	0.0.
0.0.	0.0.	0.0.	0.0.	0.0.	0.0.	0.0.	0.0.	0.0.	0.0.	0.0.
0.0.	0.0.	0.0.	0.0.							

SEND

LINE 00 FROM ACCELERATION END TO TARGET STATION 1

1	1	1.00143	2.06775	1.21190	3.50152	1.04614	.93726	1.98372	-1.20494	-1.48547	1.00202	.99799
2	1	1.46176	3.24758	-1.06211	-1.68157	2.18652	.38837	1.08227	-1.54513	-1.70996	.99192	1.00916
3	1	1.33290	2.47858	-.74881	-.91946	2.14908	.32662	1.04324	-1.60128	-2.11246	1.01983	.98056
4	1	1.38338	3.15147	-.32336	-.01964	2.39968	.21958	.85960	-1.89550	-2.82903	.99190	1.00816
5	1	-1.30126	-2.39492	1.46057	1.91931	2.67382	-1.15318	-.25389	-5.31890	-2.05069	.98580	1.01440
6	1	-1.14554	-2.14202	-1.12873	-3.02979	2.16482	-1.46093	-.36476	-.32383	-.73091	1.05297	.94969
7	1	-1.41490	-2.70326	-3.45418	-7.27072	2.46862	-1.18708	-.33043	4.59885	.42559	.98580	1.01442
8	3	1.69024	2.03702	8.05705	10.32098	.00015	.07075	-1.30171	.47534	4.93778	1.03292	.96809
9	3	1.36426	4.13063	3.01519	3.99302	.00018	.10630	-.07748	.54610	9.29204	.97084	1.03008
10	3	1.85439	2.10354	-.18654	.34456	-.00000	.28776	1.87266	-.62622	-.75150	1.04554	.95644
11	3	3.28471	4.31545	-3.11065	-3.74120	-.00024	-.18356	-.42532	-2.70835	-11.88695	.97086	1.03064
12	3	1.62475	2.17547	-8.10549	-10.21737	-.00017	-.59324	-2.09851	-1.17031	-5.77167	1.03296	.96811
13	3	-1.98243	-1.52061	1.54747	.72955	-.00144	1.49569	2.73711	3.95131	7.90453	.99236	1.00773
14	3	-1.74253	-1.40917	-1.30947	-1.01408	-.00122	1.78444	3.30587	.17243	.86291	1.03114	.96978
15	3	-2.13155	-1.72135	-3.73204	-3.47914	-.00142	1.51887	2.84769	-3.37391	-5.66183	.99182	1.00826
16	1	3.44763	-2.38720	6.64509	3.82287	.00000	-3.14469	1.97155	-6.11680	3.50912	.99314	1.00774
17	1	1.23293	-1.71828	-5.17055	3.06562	.00000	-3.68823	2.28923	-2.36396	1.20216	1.02270	.97856
18	1	3.26510	-1.71652	-.04067	.32639	.00000	-3.42074	2.10673	3.94891	-2.72533	.99665	1.00414
19	1	-.91409	.21354	-5.58848	3.86154	-.70000	-2.52941	1.17202	9.74846	-4.90707	1.01357	.98738
20	1	-1.17879	1.00844	-3.81466	2.42944	-1.00499	-1.97748	.90199	9.89923	-5.02861	.98529	1.01571
21	1	1.87392	-3.31387	.95858	-1.16208	-3.12434	.71607	-1.41487	1.46287	-1.49360	.99975	1.00105
22	1	1.44227	-3.30957	-1.11944	2.49801	-3.08549	.77902	-1.48869	2.29929	-3.10746	.99785	1.00294
23	3	1.73453	-2.22231	3.52511	-5.10485	1.20777	1.21134	-2.04979	-4.53335	8.48258	1.01706	.98406
24	3	1.03044	-5.53671	-.44041	1.01219	2.85570	-1.10270	2.03630	-13.34498	23.72796	.99039	1.01056
25	3	1.67227	-1.69023	-7.41225	12.43532	.81297	-4.31807	7.78311	.38201	-.91768	1.01073	.99021
26	3	-.34416	.83450	-4.38934	7.75015	-.80089	-.33375	.52839	12.62059	-22.97481	1.00075	.99996

PHASE SPACE X. XP. Y. YP. FOR K(MN) = 1 0. 0. 0. 0.

0 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 C(1) = 0.

ICONT = 0	PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1	0.	0.	0.
1.00000E+03	1.00000E+03	1.00000E+03	1.00000E+03	C(2) = 2.42E-07

ICONT = 156	PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1	2.2641E+06	2.1066E+07	-7.5095E+05
1.62409E-09	1.1984WE-07	5.7017E-09	1.42409E-09	C(3) = 4.636E-05

ICONT = 364	PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1	7.3029E+06	5.7205E+07	-1.2168E+06
5.24426E-10	7.39623E-08	1.58177E-09	5.24426E-10	C(4) = 1.921E-05

ICONT = 632	PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1	-3.4907E+07	-3.2708E+08	2.3846E+07
9.14963E-11	3.77395E-09	1.77863E-10	9.14963E-11	C(5) = 3.574E-06

ICONT = 806	PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1	-1.5295E+08	-5.7559E+08	-1.2193E+08
6.53821E-10	5.21205E-11	7.38151E-10	2.61966E-10	5.21205E-11

				C(6) = 2.121E-06

LINE 00 FROM ACCELERATOR END TO TARGET STATION 1

VERTICAL PLANE

TABLE FOR ABBERATIONS AX0= .1000 AXPO= .0300 AY0= .0900 AYP0= .2000							
FOR N POLEPAIRS = 2							
NO	EPSILON = PERMISSIBLE ERROR / APERTURE RADIUS A			POLEFACE MODIFICATION BY 1 BUMP			
	ERROR EXCITATION	DISPLACEMENT OF 1 POLE ONLY		EPS = H * DPHI / A (RAD)			
		RADIAL	AZIMUTHAL	PHI = 45 DEG	55 DEG	65 DEG	75 DEG
1	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
2	4.43E-05	-2.41E-05	2.40E-05	1.00E+03	1.00E+03	1.00E+03	1.00E+03
3	1.00E+03	-3.77E-05	1.11E-05	1.00E+03	1.00E+03	1.00E+03	1.00E+03
4	-2.18E-05	-4.47E-06	4.47E-06	1.00E+03	1.00E+03	1.00E+03	1.00E+03
5	1.00E+03	-5.66E-06	8.48E-06	1.82E-06	1.27E-05	-3.64E-06	-1.27E-05

WHERE A = APERTURE RADIUS.
 H = HEIGHT OF STEEL ADDED OVER DIFFERENTIAL RANGE DPHI.
 PHI = ANGLE μ RESPECT TO NEUTRAL POTENTIAL AXIS
 NN=1 = QUADRUPOLE. NN=5 = OCTUPOLE

Case b

**** = 26.

= 0.1E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.5E+00, 0.5E+00,
 0.5E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.21E+00, 0.21E+00,
 0.21E+00, 0.21E+00, 0.21E+00, 0.21E+00, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

ISROT1 = 8.

SPHASE

SABBERTN

ISROT2 = 23.

X0 = 0.389E+00.

AX0 = 0.1E+00.

IENDRT1 = 15.

Y0 = 0.347E+00.

AXPO = 0.6E+00.

IENDRT2 = 27.

XP0 = 0.301E+00.

AY0 = 0.9E+01.

IMOR = 1.

YP0 = 0.293E+00.

AYPO = 0.1E+01.

IVERT = 0.

N0 = 0.35E+00.

GN = 0.1E+02.

SEND

SEND

P0 = 0.1464E+01.

SEND

LINE 00 FROM ACCELERATOR END TO TARGET STATION 1

0

NN = 0 ICONT = 0 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 = 0. 0. 0. 0.
 0 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 C(1) = 0.

1

NN = 1 ICONT = 0 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 = 0. 0. 0. 0.
 1 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 C(2) = 2.442E+07

2

NN = 2 ICONT = 156 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 = 2.2641E+06 2.1066E+07 -7.5095E+05 3.5077E+07
 2 4.41679E-04 2.46818E-08 1.19844E-07 2.85087E-08 2.84818E-08 C(3) = 9.272E-04

3

NN = 3 ICONT = 364 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 = 7.3029E+06 5.7205E+07 -1.2168E+06 1.2644E+08
 3 1.34432E-08 1.04885E-08 7.39623E-08 7.40884E-09 7.90884E-09 C(4) = 2.897E-04

4

NN = 4 ICONT = 432 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 = -3.4907E+07 -3.2780E+08 2.3848E+07 -1.1245E+09
 4 2.89479E-09 1.82943E-09 3.77385E-09 8.89315E-10 8.89315E-10 C(5) = 3.474E-05

5

NN = 5 ICONT = 988 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 = -1.5295E+08 -5.7559E+08 -1.2193E+08 -7.6346E+08
 5 6.53821E-10 1.04241E-09 7.38151E-10 1.38983E-09 6.53821E-10 C(6) = 2.661E-05

LINE D0 FROM ACCELERATOR END TO TARGET STATION 1

V E R T I C A L P L A N E

TABLE FOR ABERRATIONS AX0= .1000 AXP0= .6000 AY0= .0900 AYP0= 1.0000

FOR N POLEPAIRS = 2

NN	EMILON = PERMISSIBLE ERROR / APERTURE RADIUS A			POLEFACE MODIFICATION BY 1 RUMP			
	ERROR EXCITATION 1 POLE ONLY	DISPLACEMENT OF 1 POLE ONLY		EPS = H * DPHI / A (RAD)			
		RADIAL	AZIMUTHAL	PHI = 45 DEG	55 DEG	65 DEG	75 DEG
1	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
2	8.86E-04	-4.83E-04	4.80E-04	1.00E+03	1.00E+03	1.00E+03	1.00E+03
3	1.00E+03	-5.88E-04	1.68E-04	1.00E+03	1.00E+03	1.00E+03	1.00E+03
4	-2.12E-04	-4.34E-05	4.34E-05	1.00E+03	1.00E+03	1.00E+03	1.00E+03
5	1.00E+03	-7.10E-05	1.06E-04	2.28E-05	1.60E-04	-4.56E-05	-1.60E-04

WHERE A = APERTURE RADIUS.

H = HEIGHT OF STEEL ADDED OVER DIFFERENTIAL RANGE DPHI.

PHI = ANGLE W/ RESPECT TO NEUTRAL POTENTIAL AXIS

NN=1 = QUADRUPOLE. NN=5 = OCTUPOLE

SDIST

Case c

IMAX = 25.

OL = 0.1E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.5E+00, 0.5E+00,
 0.5E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.21E+00, 0.21E+00,
 0.21E+00, 0.21E+00, 0.21E+00, 0.21E+00, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
 0.0, 0.0, 0.0, 0.0, 0.0.

ISDOT1 = 4.

SPHASE

SABBERTN

ISDOT2 = 23.

X0 = 0.389E+00.

AX0 = 0.1E+00.

IENDRT1 = 15.

Y0 = 0.347E+00.

AXP0 = 0.6E+00.

IENDRT2 = 27.

XP0 = 0.301E+00.

AY0 = 0.9E+01.

IMOR = 0.

YP0 = 0.293E+00.

AYP0 = 0.1E+01.

IVERI = 1.

DG = 0.35E+00.

GN = 0.5E+01.

SPID

SEND

P0 = 0.1444E+01.

SEND

LINE 00 FROM ACCELERATOR END TO TARGET STATION 1

0
 NN = 0 ICONT = 0 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 0. 0. 0. 0.
 0 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 C(1) = 0.

1
 NN = 1 ICONT = 0 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 0. 0. 0. 0.
 1 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 C(2) = 2.442E+07

2
 NN = 2 ICONT = 156 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 2.2641E+06 2.1066E+07 -7.5095E+05 3.5077E+07
 2 4.41579E-08 2.84818E-08 1.19849E-07 2.85087E-08 2.84818E-08 C(3) = 9.272E-04

3
 NN = 3 ICONT = 364 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * 7.3029E+06 5.7205E+07 -1.2168E+06 1.2644E+08
 3 1.36932E-08 1.04885E-08 7.39623E-08 7.90884E-09 7.90884E-09 C(4) = 2.897E-04

4
 NN = 4 ICONT = 832 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * -3.4907E+07 -3.2788E+08 2.3848E+07 -1.1245E+09
 4 2.86479E-09 1.82993E-09 3.77385E-09 8.89315E-10 8.89315E-10 C(5) = 3.474E-05

5
 NN = 5 ICONT = *08 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 * -1.5295E+08 -5.7559E+08 -1.2193E+08 -7.6346E+08
 5 6.53821E-10 1.04241E-09 7.38151E-10 1.30983E-09 6.53821E-10 C(6) = 2.661E-05

LINE 00 FROM ACCELERATOR END TO TARGET STATION 1

V E R T I C A L P L A N E

TABLE FOR ABBERATIONS AX0= .1000 AXP0= .6000 AY0= .0900 AYP0= 1.0000 FOR N POLEPAIRS = 2							
NN.	EPSILON = PERMISSIBLE ERROR / APERTURE RADIUS A			POLEFACE MODIFICATION BY 1 BUMP			
	ERROR EXCITATION 1 POLE ONLY	DISPLACEMENT OF 1 POLE ONLY		EPS = H * DPHI / A (RAD)			
		RADIAL	AZIMUTHAL	PHI = 45 DEG	55 DEG	65 DEG	75 DEG
1	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
2	1.77E-03	-9.66E-04	9.59E-04	1.00E+03	1.00E+03	1.00E+03	1.00E+03
3	1.00E+03	-1.14E-03	3.36E-04	1.00E+03	1.00E+03	1.00E+03	1.00E+03
4	-4.24E-04	-8.69E-05	8.69E-05	1.00E+03	1.00E+03	1.00E+03	1.00E+03
5	1.00E+03	-1.42E-04	2.13E-04	4.56E-05	3.19E-04	-9.12E-05	-3.19E-04

WHERE A = APERTURE RADIUS,
H = HEIGHT OF STEEL ADDED OVER DIFFERENTIAL RANGE DPHI,
PHI = ANGLE W/ RESPECT TO NEUTRAL POTENTIAL AXIS
NN=1 = QUADRUPOLE, NN=5 = OCTUPOLE

Case d

\$DIST

IMAX = 26.

DL = 0.1F+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.5E+00, 0.5E+00,
 0.5E+00, 0.5E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.25E+00, 0.5E+00, 0.25E+00, 0.21E+00, 0.21E+00,
 0.21E+00, 0.21E+00, 0.21E+00, 0.21E+00, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
 0.0, 0.0, 0.0, 0.0, 0.0.

ISROT1 = 0.

\$PHASE

\$ABBERTN

ISROT2 = 23.

X0 = 0.389E+00.

AX0 = 0.2E+00.

IENDRT1 = 15.

Y0 = 0.347E+00.

AXP0 = 0.6E+00.

IENDRT2 = 27.

XP0 = 0.301E+00.

AY0 = 0.2E+00.

IENDR = 0.

YP0 = 0.293E+00.

AYP0 = 0.1E+01.

IVERT = 1.

D0 = 0.35E+00.

GN = 0.5E+01.

SEND

\$END

P0 = 0.1444E+01.

\$END

LINE 00 FROM ACCELERATOR END TO TARGET STATION 1

0
 NN = 0 ICONT = 0 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 = 0. 0. 0. 0.
 0 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 C(1) = 0.

1
 NN = 1 ICONT = 0 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 = 0. 0. 0. 0.
 1 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 1.00000E+03 C(2) = 2.442E+07

2
 NN = 2 ICONT = 156 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 = 2.2641E+06 2.1066E+07 -7.5095E+05 3.5077E+07
 2 8.83758E-08 2.84818E-08 2.66331E-07 2.85087E-08 2.84818E-08 C(3) = 9.272E-04

3
 NN = 3 ICONT = 364 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 = 7.3029E+06 5.7205E+07 -1.2168E+06 1.2644E+08
 3 2.73863E-08 1.04885E-08 1.64361E-07 7.90884E-09 7.90884E-09 C(4) = 2.897E-04

4
 NN = 4 ICONT = 832 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 = -3.4907E+07 -3.2788E+08 2.3848E+07 -1.1245E+09
 4 5.72954E-09 1.82993E-09 8.38633E-09 8.89315E-10 8.89315E-10 C(5) = 3.474E-05

5
 NN = 5 ICONT = 908 PHASE SPACE X, XP, Y, YP, FOR K(NN) = 1 = -1.5295E+08 -5.7559E+08 -1.2193E+08 -7.6346E+08
 5 1.30744E-09 1.04241E-09 1.64034E-09 1.30983E-09 1.04241E-09 C(6) = 4.242E-05

VERTICAL PLANE

TABLE FOR ABERRATIONS AX0= .2000 AXP0= .6000 AY0= .2000 AYP0= 1.0000							
FOR N POLEPAIRS = 2							
NN	EPSILON = PERMISSIBLE ERROR / APERTURE RADIUS A			POLEFACE MODIFICATION BY 1 BUMP			
	ERROR EXCITATION 1 POLE ONLY	DISPLACEMENT OF 1 POLE ONLY		EPS = H * OPHI / A (RAD)			
		RADIAL	AZIMUTHAL	PHI = 45 DEG	55 DEG	65 DEG	75 DEG
1	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
2	1.77E-03	-9.66E-04	9.59E-04	1.00E+03	1.00E+03	1.00E+03	1.00E+03
3	1.00E+03	-1.14E-03	3.36E-04	1.00E+03	1.00E+03	1.00E+03	1.00E+03
4	-4.24E-04	-8.69E-05	8.69E-05	1.00E+03	1.00E+03	1.00E+03	1.00E+03
5	1.00E+03	-2.26E-04	3.79E-04	7.27E-05	5.09E-04	-1.45E-04	-5.09E-04

WHERE A = APERTURE RADIUS.

H = HEIGHT OF STEFL ADDED OVER DIFFERENTIAL RANGE OPHI.

PHI = ANGLE // RESPECT TO NEUTRAL POTENTIAL AXIS

NN=1 = QUADRUPOLE. NN=5 = OCTUPOLE