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The QTUNE Program--The AGS Extracted Beam Transport Program

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AGS Division Technical Note
No. 181

The "QTUNE" Program--The AGS Extracted Beam Transport Program

J.F. Ryan
August 4, 1982

Introduction

The purpose of this Technical Note is to document the extracted beam transport program called "QTUNE". This program can be used to calculate beam sizes in the four SEB lines and the FEB line from the ring to the primary targets using the known power supply and magnet characteristics. Typical TTY and Versatec outputs for the "U" line and "C" line are shown in Figures 1 and 2. The program is run with the R-R QTUNE command when in the operations area.

Discussion

The primary purpose of this program is to calculate the horizontal and vertical beam sizes in the various beam lines using the present settings of the power supplies and the best known values of beam emittance. Beam splitting is not considered. All beam is assumed going down each line when calculating beam sizes. The magnetic data is calculated from the calculated magnet current using a 4th order power series. Power supply and magnet current limitations for the beam lines are included. Various groups of quadrupoles in the beam lines can be tuned to vary waist locations and sizes.

This program uses 5 by 5 matrices to include momentum dispersion effects. Because this program is similar to a first order "TRANSPORT" run, one output option will write on the "MATRIC-DAT" data file matrices and beam sizes in a similar format to "TRANSPORT". All other output data is written on the "QTUNE-DAT" data file which should be printed after exiting from the program.

Program Options

The various program options are shown on the HELP file in Figure 3.

The "A" command will print on the "MATRIC-DAT" file the transport matrices and emittances using the beam line chosen with the constant BFILE and the power supply data chosen with constraints IAGSFG and IENUT. Figures 4A-B show a part of this file.

The "B" command prints the calculated currents and fields in the magnets. The power supply values are chosen with the constants BFILE, IAGSFG and IENUT. Figures 5A-B show this file for the "C" line.

The "H", "D", "E", "K" and "L" command descriptions are shown on Figure 3.

The "C" command is used to change one or more constants shown in Figure 6 using the NAMELIST feature. These constants only have numerical values. Those that effect the graphics output are XYRANG, ZRANGE, LFRAME, AND TEKVER. The input beam at H13 (FEB) or F13 (SEB) is described with PBEAM, ABEF13, ABEH13, DPP and H13MOM (FEB only). The beam line is chosen with BFILE, and IAGSFG selects if the power supply command or readback is used to calculate the magnet current. An off-line program, "ENUTQ", can be chosen to supply the power supply values and is selected using constant IENUT. This program, similar to "AGAST", rather than the TTY option, should be used for off-line communication since these values can be easily transferred to and from the on-line program "AGAST". The constant TEGFG is used to change to a different "ENUTQ" file.

The "G" command is used to plot beam sizes as on Figures 1, 2 or 7. An "E" will exit from this option. During FEB or SEB operation the constants are initialized so that a "G" command will plot the "U" line or "C" line beam sizes. The values of certain parameters are printed on the graph, "QTUNE-DAT", and sent to "AGAST" or "ENUTQ". These are shown in Figure 8 and defined in Figure 9.

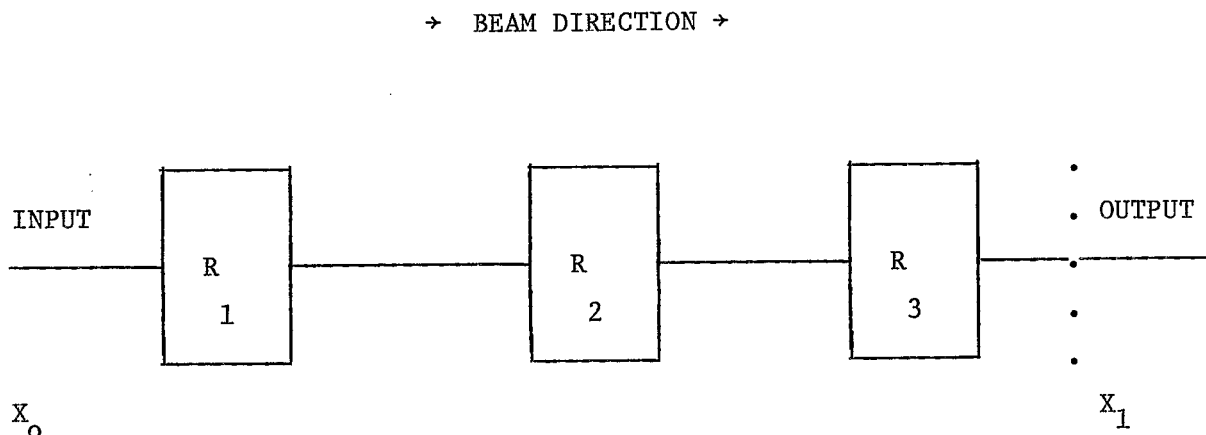
The "P" and "M" commands will print on "QTUNE-DAT" the constants of the beam line and magnets as shown in Figures 10 and 11.

The "T" command, shown in Figure 12, is used to tune various groups of quads to meet desired values of waist parameters described in Figure 9. The beam sizes at the targets cannot be used to tune the quads before the targets, but can be varied by changing the waist locations and sizes. If tuning is mathematically successful and the program is on-line, the quad power supplies will be changed.

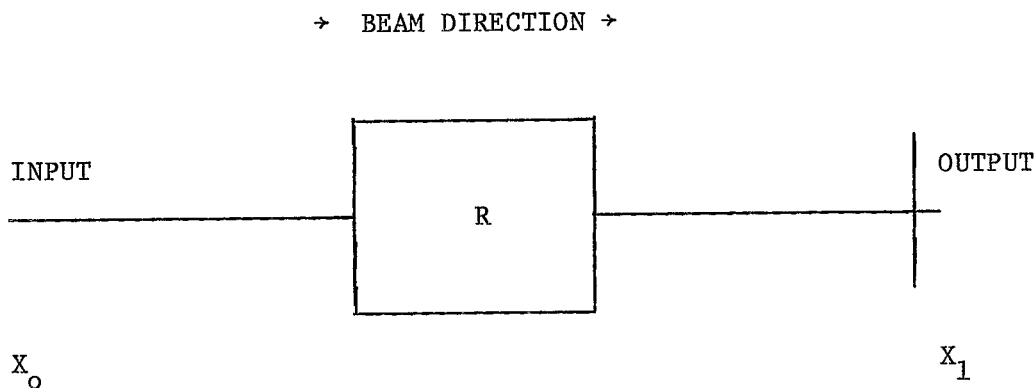
The "W" command calculates the values of the FEB or SEB parameters without plotting the graph.

Theory and Units

The beam is considered a collection of particles traveling down a beam line with the magnetic elements described with a matrix R_i .



Or



$$[R] = [R_3] \times [R_2] \times [R_1] \tag{1}$$

$$\text{DET } [R] = 1$$

The characteristics of the beam particles at the output can be determined from the following matrix equation:

$$[X_1] = [R] \times [X_0] \tag{2}$$

"QTUNE" uses a 5x5 order matrix for the magnetic elements, $[R]$. Equation 2 can be expanded to:

$$\begin{bmatrix} X_1 \\ \theta_1 \\ Y_1 \\ \phi_1 \\ \delta_1 \end{bmatrix} = \begin{bmatrix} R_{11} & R_{12} & R_{13} & R_{14} & R_{15} \\ R_{21} & R_{22} & R_{23} & R_{24} & R_{25} \\ R_{31} & R_{32} & R_{33} & R_{34} & R_{35} \\ R_{41} & R_{42} & R_{43} & R_{44} & R_{45} \\ R_{51} & R_{52} & R_{53} & R_{54} & R_{55} \end{bmatrix} \times \begin{bmatrix} X_0 \\ \theta_0 \\ Y_0 \\ \phi_0 \\ \delta_0 \end{bmatrix} \quad (3)$$

where standard TRANSPORT definitions apply to the particle characteristics:

X_0 ---- horizontal displacement of input ray, in inches, with respect to assumed central trajectory.

θ_0 ---- the angle (mr) that this input ray makes in horizontal plane with respect to central trajectory.

Y_0 ---- vertical displacement of input ray (inches) with respect to central trajectory.

ϕ_0 ---- the angle (mr) that this input ray makes in vertical plane with respect to central trajectory.

δ_0 ---- $\Delta P/P$ = fractional momentum deviation (%) of this input ray and the assumed central trajectory.

The units for the [R] matrix are:

$$\begin{array}{ccccc}
 R_{11} \left(\frac{\text{In } X}{\text{In } X} \right) & R_{12} \left(\frac{\text{In } X}{\text{mr } X} \right) & R_{13} \left(\frac{\text{In } X}{\text{In } Y} \right) & R_{14} \left(\frac{\text{In } X}{\text{mr } Y} \right) & R_{15} \left(\frac{\text{In } X}{\%} \right) \\
 R_{21} \left(\frac{\text{mr } X}{\text{In } X} \right) & R_{22} \left(\frac{\text{mr } X}{\text{mr } X} \right) & R_{23} \left(\frac{\text{mr } X}{\text{In } Y} \right) & R_{24} \left(\frac{\text{mr } X}{\text{mr } Y} \right) & R_{25} \left(\frac{\text{mr } X}{\%} \right) \\
 R_{31} \left(\frac{\text{In } Y}{\text{In } X} \right) & R_{32} \left(\frac{\text{In } Y}{\text{mr } X} \right) & R_{33} \left(\frac{\text{In } Y}{\text{In } Y} \right) & R_{34} \left(\frac{\text{In } Y}{\text{mr } Y} \right) & R_{35} \left(\frac{\text{In } Y}{\%} \right) \\
 R_{41} \left(\frac{\text{mr } Y}{\text{In } X} \right) & R_{42} \left(\frac{\text{mr } Y}{\text{mr } X} \right) & R_{43} \left(\frac{\text{mr } Y}{\text{In } Y} \right) & R_{44} \left(\frac{\text{mr } Y}{\text{mr } Y} \right) & R_{45} \left(\frac{\text{mr } Y}{\%} \right) \\
 R_{51} \left(\frac{\%}{\text{In } X} \right) & R_{52} \left(\frac{\%}{\text{mr } X} \right) & R_{53} \left(\frac{\%}{\text{In } Y} \right) & R_{54} \left(\frac{\%}{\text{mr } Y} \right) & R_{55} \left(\frac{\%}{\%} \right)
 \end{array}$$

Figures 4A-B show the individual element matrix and total [R] matrix at different points in the "C" line. "QTUNE" calculates matrices for drift spaces, horizontal and vertical focussing quadrupoles, wedge dipole and pitching magnets without edge focussing, and rectangular dipole and pitching magnets with edge focussing.

The beam is considered an array of particles that is described with a 5th order symmetrical sigma ellipsoid. For historical reasons the program uses a rms beam and then converts this to a 99% beam. The symmetric SIGMA matrix at at the beam line input is:

$$[\sigma_o] = \begin{bmatrix} \sigma_{11} & \sigma_{21} & \sigma_{31} & \sigma_{41} & \sigma_{51} \\ \sigma_{21} & \sigma_{22} & \sigma_{32} & \sigma_{42} & \sigma_{52} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} & \sigma_{43} & \sigma_{53} \\ \sigma_{41} & \sigma_{42} & \sigma_{43} & \sigma_{44} & \sigma_{54} \\ \sigma_{51} & \sigma_{52} & \sigma_{53} & \sigma_{54} & \sigma_{55} \end{bmatrix} \quad (4)$$

$\sqrt{\sigma_{11}}$ = X_{\max} = maximum (half) width of the beam envelop in the X (bend) plane at the given point (inches).

$\sqrt{\sigma_{22}}$ = θ_{\max} = maximum (half) angular divergence of the beam envelope in the X-bend plane.

$\sqrt{\sigma_{33}}$ = Y_{\max} = maximum (half) height of the beam envelope.

$\sqrt{\sigma_{44}}$ = ϕ_{\max} = maximum (half) angular divergence of the beam envelope in the Y (non-bend) plane.

$\sqrt{\sigma_{55}}$ = δ_{\max} = half-width (1/2 $\Delta P/P$) of the momentum interval being transmitted by the system.

The coupling elements are the σ_{ij} elements for i not equal to j.

"QTUNE" assumes that the input beam for the SEB or FEB lines have no input X-Y coupling or:

$$[\sigma_o] = \begin{bmatrix} \sigma_{11} & \sigma_{21} & 0 & 0 & 0 \\ \sigma_{21} & \sigma_{22} & 0 & 0 & 0 \\ 0 & 0 & \sigma_{33} & \sigma_{43} & 0 \\ 0 & 0 & \sigma_{43} & \sigma_{44} & 0 \\ 0 & 0 & 0 & 0 & \sigma_{55} \end{bmatrix} \quad (5)$$

The input FEB beam is also assumed to have input momentum dispersion or the R_{15} and R_{25} elements are non-zero at H13.

At any point in the beam line, the SIGMA matrix $[\sigma_1]$ can be found from the input matrix $[\sigma_0]$ and the total $[R]$ matrix to this point:

$$[\sigma_1] = [R] \times [\sigma_0] \times [R^T] \tag{6}$$

where $[R^T]$ is the transpose of $[R]$.

The graphs of Figures 1 and 2 are obtained by plotting $\sqrt{\sigma_{11}}$ and $\sqrt{\sigma_{33}}$ along the beam line for a 99% beam. The program also plots the horizontal momentum dispersion parameters, R_{15} and R_{25} , along the beam line.

The input SIGMA matrix, $[\sigma_0]$ is obtained from the constants ABEF13 or ABEH13 and DPP. For no X-Y coupling, the horizontal part of $[\sigma_0]$ is:

$$\begin{bmatrix} \sigma_{11} & \sigma_{21} \\ \sigma_{21} & \sigma_{22} \end{bmatrix} = \epsilon_H \begin{bmatrix} \beta_H & -\alpha_H \\ -\alpha_H & \gamma_H \end{bmatrix} \tag{7}$$

$$\begin{aligned} \sigma_{11} &= \epsilon_H \beta_H \\ \sigma_{21} &= -\epsilon_H \alpha_H \\ \sigma_{22} &= \epsilon_H \gamma_H = \epsilon_H \left(\frac{1 + \alpha_H^2}{\beta_H} \right) \end{aligned} \quad \epsilon = \text{DET} \begin{pmatrix} \sigma_{11} & \sigma_{21} \\ \sigma_{21} & \sigma_{22} \end{pmatrix}$$

where α , β , and ϵ are the rms beam Twiss parameters as specified in ABEF13 or ABEH13. These are initialized to the best know values of the emittance at F13 (from H. Weisberg) or H13 (W. Weng).

- α - dimensionless
- β - kiloinch
- ϵ - epilson = rms emittance (inch-mrad)

The 99% beam emittance = 9.2103 ϵ_{rms}

The 99% beam width plotted = 3.0348 (beam width for rms beam)

The vertical $[\sigma_0]$ elements, σ_{33} , σ_{43} , and σ_{44} are obtained in a similar way.

If X-Y coupling occurs downstream, the beam ellipsoid is assumed to have the same 5th order volume or no losses are assumed. The horizontal and vertical emittances may change. To determine the location of a waist, the emittance in that plane is needed at the entrance to the drift space. The emittance is the projection of the ellipsoid on that plane or

$$\epsilon_H = \text{DET} \begin{pmatrix} \sigma_{11} & \sigma_{21} \\ \sigma_{21} & \sigma_{22} \end{pmatrix} \quad \text{or} \quad \epsilon_V = \text{DET} \begin{pmatrix} \sigma_{33} & \sigma_{43} \\ \sigma_{43} & \sigma_{44} \end{pmatrix} \quad (8)$$

where DET is the determinant.

Equation (6) can be expanded and simplified for an input beam with no X-Y coupling (Equation (5)).

$$[\sigma]_1 = [R] \times [\sigma]_0 \times [R^T] \quad (6)$$

At Point 1

$$\begin{aligned} (\sigma_{11})_1 = (X_{\max})^2 &= (\sigma_{11})_0 R_{11}^2 + 2(\sigma_{21})_0 R_{11}R_{12} + (\sigma_{22})_0 R_{12}^2 \\ &+ (\sigma_{33})_0 R_{13}^2 + 2(\sigma_{43})_0 R_{13}R_{14} + (\sigma_{44})_0 R_{14}^2 \\ &+ (\sigma_{66})_0 R_{16}^2 \end{aligned} \quad (7)$$

$$\begin{aligned} (\sigma_{33})_1 = (Y_{\max})^2 &= (\sigma_{11})_0 R_{31}^2 + 2(\sigma_{21})_0 R_{32}R_{31} + (\sigma_{22})_0 R_{32}^2 \\ &+ (\sigma_{33})_0 R_{33}^2 + 2(\sigma_{43})_0 R_{34}R_{33} + (\sigma_{44})_0 R_{34}^2 \\ &+ (\sigma_{66})_0 R_{36}^2 \end{aligned} \quad (8)$$

$$\begin{aligned} (\sigma_{13})_1 = \text{tilt component} &= (\sigma_{11})_0 R_{11}R_{31} + (\sigma_{21})_0 (R_{12}R_{31} + R_{11}R_{32}) \\ &+ (\sigma_{22})_0 R_{12}R_{32} + (\sigma_{33})_0 R_{13}R_{33} + (\sigma_{43})_0 \times \\ &\quad (R_{14}R_{33} + R_{13}R_{34}) \\ &+ (\sigma_{44})_0 R_{14}R_{34} + (\sigma_{66})_0 R_{16}R_{36} \end{aligned} \quad (9)$$

Where the $(\sigma_{ij})_0$ are the input beam components and the R_{ij} are the total matrix elements from the input to the Point 1 in the beam line. The input beam Twiss parameters $(\alpha, \beta, \epsilon)$ can be found experimentally by fitting several beam width measurements to Equation (6) or (7) knowing the elements of the $[R]$ matrix at the measurement point.

mn

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U LINE H13 TO TGT

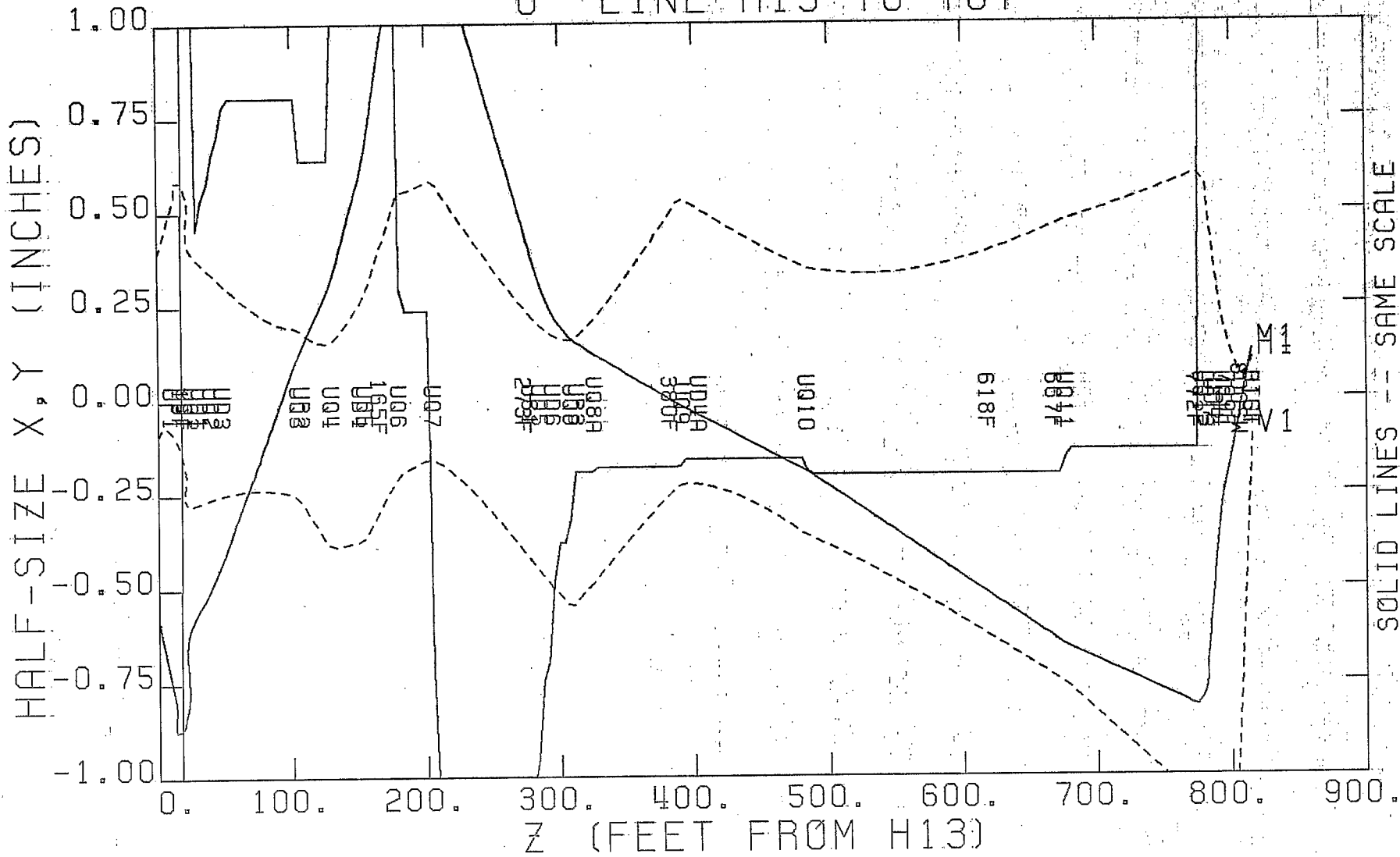
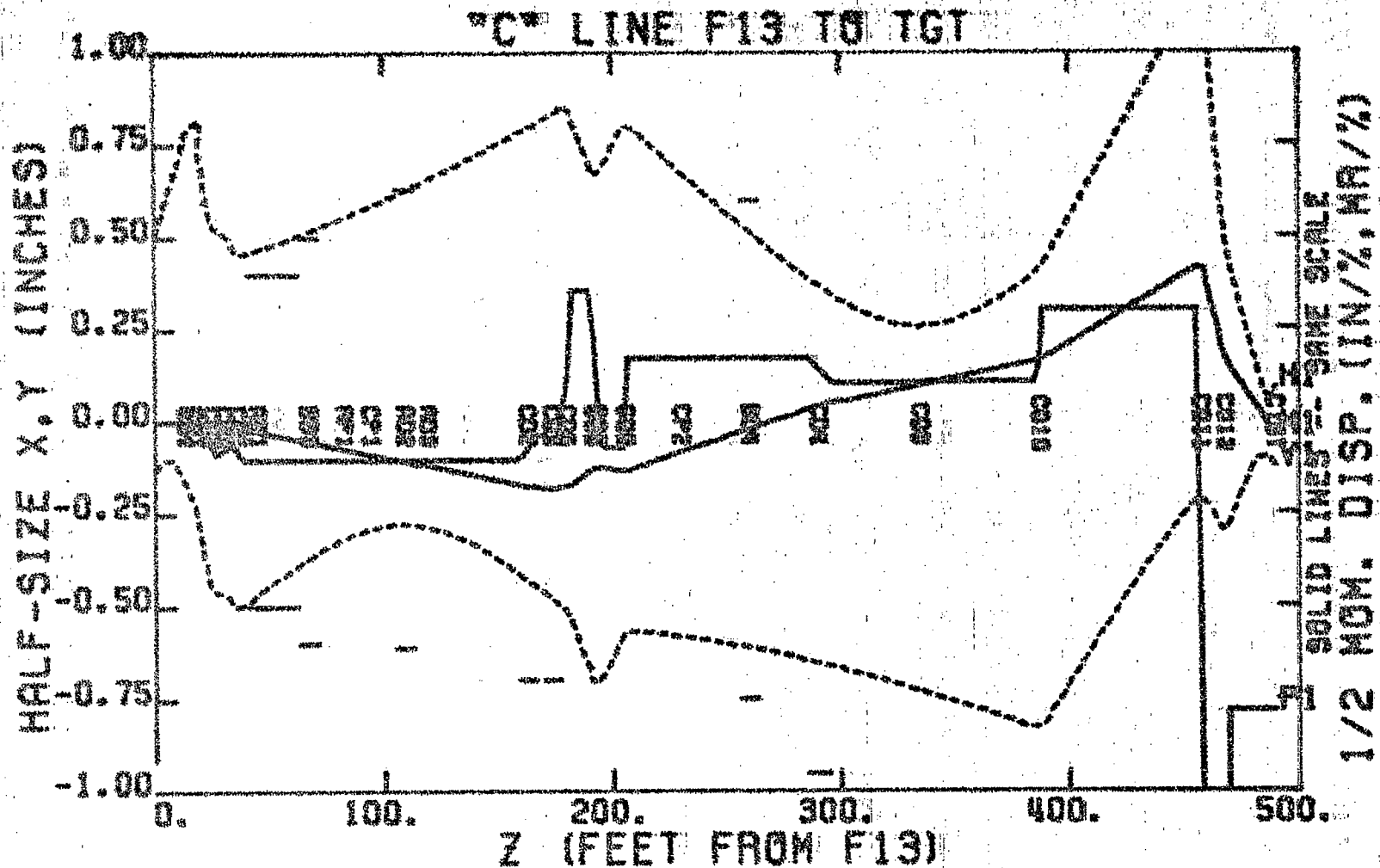


Figure 1

060



CM%HZ	CM%HX	CM%UZ	CM%UX	CA%HI	CA%HO	CA%VI	CA%VO
-199.8	404.0	1297.0	277.0	-1858.7	2977.5	-1533.4	-162.7
CT%HZ	CT%HX	CT%UZ	CT%UX	BT%HZ	BT%HX	BT%UZ	BT%UX
-33.4	62.5	-56.6	95.3	-1.0	62.0	3.0	32.0
AT%HZ	AT%HX	AT%UZ	AT%UX	BMDIV	TG%CH	TG%CU	
854.0	224.0	-1592.0	127.0	86.5	93.0	125.8	

Figure 2

VALID COMMANDS:

- H <CR> -- TYPES THIS HELP MESSAGE.
A <CR> -- PRINT OUT TRANSPORT MATRICES & EMITTANCES ON "MATRIC.DAT".
B <CR> -- PRINT ON "QTUNE.DAT" BEAM LINE DATA WITH FIELDS & CURRENTS IN
MAGNETS.
C <CR> -- CHANGE THE CONSTANTS.
D <CR> -- DELETE (START OVER) ON THE "QTUNE.DAT" FILE.
E <CR> -- EXIT.
G <CR> -- PLOT BEAM PROFILES & GET WAIST PARAMETERS FROM PRESENT
MAGNET SETTINGS.
K <CR> -- TYPE OUT CONSTANTS AND THEIR DEFINITIONS.
L <CR> -- LIST (PRINT) ON "QTUNE.DAT" CONSTANTS & DEFINITIONS.
M <CR> -- PRINT ON "QTUNE.DAT" MAGNET LENGTHS & FIELD VS CURRENT POWER
SERIES COEFF. FOR BEAM LINE MAGNETS.
P <CR> -- PRINT ON "QTUNE.DAT" POWER SUPPLY PARAMETERS FOR BEAM LINE
MAGNETS.
T <CR> -- TUNE THE QUADS BY VARYING THE QUADS OR WAIST PARAMETERS ON
AGAST AND PLOT BEAM PROFILES.
W <CR> -- CALCULATES WAIST PARAMETERS FROM AGAST COMMANDS & SEND WAIST
INFORMATION TO AGAST FOR MORNING REPORT; NO PLOTS MADE.

COMMAND: (A, B, C, D, E, G, H, K, L, M, P, T, W,) :

Figure 3

ORMS PARAMETERS:

ALPHA, BETA, EPSILON (H,V) AT F18: -6.3388 1.9952 0.0140 0.8708 0.1279 0.0150

CD1 (-2243) CQ1 (-1898) CQ2 (1073) CQ3 (-303) CQ4 (687) CD283(3269) CD283(3269) CQ588(-1105) CQ687(1000) CQ687(1000) CQ588(-1105) CD4 (-2681) CQ9 (1) CQ10 (2658) CQ11(-3502) CQ12 (2390) CD3T (0)

ELEMENT	Z(INCHES)	ELEMENT OR TOTAL MATRIX FROM START					TRANSPORT BEAM MATRIX				
START ===	1.00000	0.00000	0.00000	0.00000	0.00000						
	0.00000	1.00000	0.00000	0.00000	0.00000						
	0.00000	0.00000	1.00000	0.00000	0.00000						
	0.00000	0.00000	0.00000	1.00000	0.00000						
	0.00000	0.00000	0.00000	0.00000	1.00000						
0.000 INCHES											
TOTAL MATRIX ===	1.00000	0.00000	0.00000	0.00000	0.00000	0.507 IN					
	0.00000	1.00000	0.00000	0.00000	0.00000	1.631 MR	0.988				
	0.00000	0.00000	1.00000	0.00000	0.00000	0.133 IN	0.000	0.000			
	0.00000	0.00000	0.00000	1.00000	0.00000	1.378 MR	0.000	0.000	-0.657		
	0.00000	0.00000	0.00000	0.00000	1.00000	0.000 PC	0.000	0.000	0.000	0.000	
0.000 INCHES											
===	1.00000	0.14383	0.00000	0.00000	0.00000						
	0.00000	1.00000	0.00000	0.00000	0.00000						
	0.00000	0.00000	1.00000	0.14383	0.00000						
	0.00000	0.00000	0.00000	1.00000	0.00000						
	0.00000	0.00000	0.00000	0.00000	1.00000						
143.825 INCHES											
TOTAL MATRIX ===	1.00000	0.14383	0.00000	0.00000	0.00000	0.740 IN					
	0.00000	1.00000	0.00000	0.00000	0.00000	1.631 MR	0.994				
	0.00000	0.00000	1.00000	0.14383	0.00000	0.150 IN	0.000	0.000			
	0.00000	0.00000	0.00000	1.00000	0.00000	1.378 MR	0.000	0.000	0.742		
	0.00000	0.00000	0.00000	0.00000	1.00000	0.000 PC	0.000	0.000	0.000	0.000	
143.825 INCHES											
CD1 ===	1.00000	0.03435	0.00000	0.00000	-0.00201						
	-0.00000	1.00000	0.00000	0.00000	-0.11699						
	0.00000	0.00000	0.99993	0.03435	0.00000						
	0.00000	0.00000	-0.00398	0.99993	0.00000						
	0.00000	0.00000	0.00000	0.00000	1.00000						
178.175 INCHES											
TOTAL MATRIX ===	1.00000	0.17817	0.00000	0.00000	-0.00201	0.796 IN					
	-0.00000	1.00000	0.00000	0.00000	-0.11699	1.631 MR	0.995				
	0.00000	0.00000	0.99993	0.17817	0.00000	0.187 IN	0.000	0.000			
	0.00000	0.00000	-0.00398	0.99993	0.00000	1.378 MR	0.000	0.000	0.845		
	0.00000	0.00000	0.00000	0.00000	1.00000	0.000 PC	0.000	0.000	0.000	0.000	
178.175 INCHES											
===	1.00000	0.00308	0.00000	0.00000	0.00000						
	0.00000	1.00000	0.00000	0.00000	0.00000						
	0.00000	0.00000	1.00000	0.00308	0.00000						
	0.00000	0.00000	0.00000	1.00000	0.00000						
	0.00000	0.00000	0.00000	0.00000	1.00000						
186.250 INCHES											
TOTAL MATRIX ===	1.00000	0.18625	0.00000	0.00000	-0.00295	0.899 IN					
	-0.00000	1.00000	0.00000	0.00000	-0.11699	1.631 MR	0.995				
	0.00000	0.00000	0.99990	0.18623	0.00000	0.197 IN	0.000	0.000			
	0.00000	0.00000	-0.00398	0.99993	0.00000	1.378 MR	0.000	0.000	0.860		
	0.00000	0.00000	0.00000	0.00000	1.00000	0.000 PC	0.000	0.000	0.000	0.000	
186.250 INCHES											

Figure 4A

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CQ1	===	0.83149	0.03601	0.00000	0.00000	0.00000															
		-6.19288	0.83149	0.00000	0.00000	0.00000															
		0.00000	0.00000	1.12339	0.03903	0.00000															
		0.00000	0.00000	6.71290	1.12339	0.00000															
		0.00000	0.00000	0.00000	0.00000	1.00000															
		223.750 INCHES																			
TOTAL MATRIX	===	0.83149	0.20018	0.00000	0.00000	-0.00682	0.771 IN														
		-6.19288	-0.27193	0.00000	0.00000	-0.00483	3.580 MR	-0.999													
		0.00000	0.00000	1.12312	0.24822	0.00000	0.269 IN	0.000	0.000												
		0.00000	0.00000	6.70775	2.37285	0.00000	2.767 MR	0.000	0.000	0.983											
		0.00000	0.00000	0.00000	0.00000	1.00000	0.000 PC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		223.750 INCHES																			
CQ2	===	1.00000	0.04650	0.00000	0.00000	0.00000															
		0.00000	1.00000	0.00000	0.00000	0.00000															
		0.00000	0.00000	1.00000	0.04650	0.00000															
		0.00000	0.00000	0.00000	1.00000	0.00000															
		0.00000	0.00000	0.00000	0.00000	1.00000															
		270.250 INCHES																			
TOTAL MATRIX	===	0.59352	0.18754	0.00000	0.00000	-0.01076	0.605 IN														
		-6.19288	-0.27193	0.00000	0.00000	-0.00483	3.580 MR	-0.998													
		0.00000	0.00000	1.43503	0.35856	0.00000	0.396 IN	0.000	0.000												
		0.00000	0.00000	6.70775	2.37285	0.00000	2.767 MR	0.000	0.000	0.992											
		0.00000	0.00000	0.00000	0.00000	1.00000	0.000 PC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		270.250 INCHES																			
CQ3	===	1.16467	0.05219	0.00000	0.00000	0.00000															
		6.83020	1.16467	0.00000	0.00000	0.00000															
		0.00000	0.00000	0.84390	0.04690	0.00000															
		0.00000	0.00000	-6.13762	0.84390	0.00000															
		0.00000	0.00000	0.00000	0.00000	1.00000															
		319.750 INCHES																			
TOTAL MATRIX	===	0.36805	0.20422	0.00000	0.00000	-0.01696	0.518 IN														
		-3.15883	0.96421	0.00000	0.00000	-0.17229	0.250 MR	-0.095													
		0.00000	0.00000	1.52559	0.41386	0.00000	0.463 IN	0.000	0.000												
		0.00000	0.00000	-3.14701	-0.19824	0.00000	0.315 MR	0.000	0.000	-0.326											
		0.00000	0.00000	0.00000	0.00000	1.00000	0.000 PC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		319.750 INCHES																			
CQ4	===	1.00000	0.02050	0.00000	0.00000	0.00000															
		0.00000	1.00000	0.00000	0.00000	0.00000															
		0.00000	0.00000	1.00000	0.02050	0.00000															
		0.00000	0.00000	0.00000	1.00000	0.00000															
		0.00000	0.00000	0.00000	0.00000	1.00000															
		340.250 INCHES																			
TOTAL MATRIX	===	0.30330	0.22399	0.00000	0.00000	-0.02049	0.518 IN														
		-3.15883	0.96421	0.00000	0.00000	-0.17229	0.250 MR	-0.085													
		0.00000	0.00000	1.46108	0.40980	0.00000	0.461 IN	0.000	0.000												
		0.00000	0.00000	-3.14701	-0.19824	0.00000	0.315 MR	0.000	0.000	-0.313											
		0.00000	0.00000	0.00000	0.00000	1.00000	0.000 PC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		340.250 INCHES																			
CQ5	===	0.95560	0.04877	0.00000	0.00000	0.00000															
		-1.78052	0.95560	0.00000	0.00000	0.00000															
		0.00000	0.00000	1.04507	0.05024	0.00000															
		0.00000	0.00000	1.83441	1.04507	0.00000															
		0.00000	0.00000	0.00000	0.00000	1.00000															
		389.750 INCHES																			
TOTAL MATRIX	===	0.13579	0.26107	0.00000	0.00000	-0.02798	0.494 IN														
		-3.55861	0.52257	0.00000	0.00000	-0.12816	0.972 MR	-0.963													
		0.00000	0.00000	1.36881	0.41831	0.00000	0.477 IN	0.000	0.000												
		0.00000	0.00000	-0.50361	0.54457	0.00000	0.206 MR	0.000	0.000	0.933											
		0.00000	0.00000	0.00000	0.00000	1.00000	0.000 PC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
		389.750 INCHES																			

Figure 4B

"C" LINE MAGNETS FROM F13 TO CMTARGET

---ELEMENT---MAGNET			---POWER SUPPLY DATA---				---MAGNET DATA FOR 29,000 GEV/C---			
#	NAME	LABEL	KIND	DDF1	CMD/RDBK	DDF2	CMD/RDBK	CURRENT(KA)	KG-IN OR KG-IN	GAIN(GEL)
1			DRIFT							0.0
2	CD1	CD1	RDPOL	CD1	-2243		0	1.40188	-445.5247	-0.67027
3			DRIFT							0.0
4	CQ1	CQ1	QUAD	CQ1	-1898		0	1.42350	-6.5502	-6.55019
5			DRIFT							0.0
6	CQ2	CQ2	QUAD	CQ2	1073		0	1.07300	4.9843	4.98428
7			DRIFT							0.0
8	CQ3	CQ3	QUAD	CQ3	-303		0	0.30300	-1.3905	-1.39052
9			DRIFT							0.0
10	CQ4	CQ4	QUAD	CQ4	687		0	0.51525	2.3747	2.37467
11			DRIFT							0.0
12		AB1	DRIFT							0.0
13			DRIFT							0.0
14		BB3	DRIFT							0.0
15			DRIFT							0.0
16		AP1	DRIFT							0.0
17			DRIFT							0.0
18		CP1	DRIFT							0.0
19			DRIFT							0.0
20		AD2	DRIFT							0.0
21			DRIFT							0.0
22		AD3	DRIFT							0.0
23			DRIFT							0.0
24	CD2	CD2	RDPOL	CD283	3269		0	1.22588	510.3198	0.76775
25			DRIFT							0.0
26	CD3	CD3	RDPOL	CD283	3269	CD3T2	0	1.22588	510.3198	0.76775
27			DRIFT							0.0
28	CQ5	CQ5	QUAD	CQ583	-1105		0	0.27625	-4.0898	-4.08979
29			DRIFT							0.0
30	CQ6	CQ6	QUAD	CQ687	1000		0	0.25000	3.7738	3.77383
31			DRIFT							0.0
32	CQ7	CQ7	QUAD	CQ687	1000		0	0.25000	3.7738	3.77383
33			DRIFT							0.0
34	CQ8	CQ8	QUAD	CQ583	-1105		0	0.27625	-4.0898	-4.08979
35			DRIFT							0.0
36		CP2	DRIFT							0.0
37			DRIFT							0.0
38		BD4	DRIFT							0.0
39			DRIFT							0.0
40	CD4	CD4	RDPOL	CD4	-2681		0	1.00537	-514.3780	-0.77386
41			DRIFT							0.0
42	CQ9	CQ9	QUAD	CQ9	1		0	0.00006	0.0126	0.01256
43			DRIFT							0.0
44	CQ10	CQ10	QUAD	CQ10	2658		0	0.99675	1.2642	1.26418
45			DRIFT							0.0
46	CQ11	CQ11	QUAD	CQ11	-3502		0	1.31325	-6.0712	-6.07116
47			DRIFT							0.0
48	CQ12	CQ12	QUAD	CQ12	2390		0	1.79250	3.0039	3.00388
49			DRIFT							0.0
50		CTGT	DRIFT							0.0

NOTE *****

- A) CMD/RDBK -- READINGS ARE FROM AGAST CMDS. THE "A" RDBK IS NEGATIVE -- IE. 2140A = -2140.
- B) DDF2 (SECONDARY P.S. READBACKS) ARE SA3 RDBKS WITH THE POLARITY OF NORMAL READBACK.

Figure 5A

C) KGI - KG/IN FOR QUADS; KG-IN FOR DIPOLES.
D) GEL = @ FOR DRIFT; -KG/IN FOR H.F. QUAD; +KG/IN FOR V.F. QUAD; BEND ANGLE (DEGREES) FOR DIPOLES (+ = EAST).
(+ = DOWN FOR PITCH)

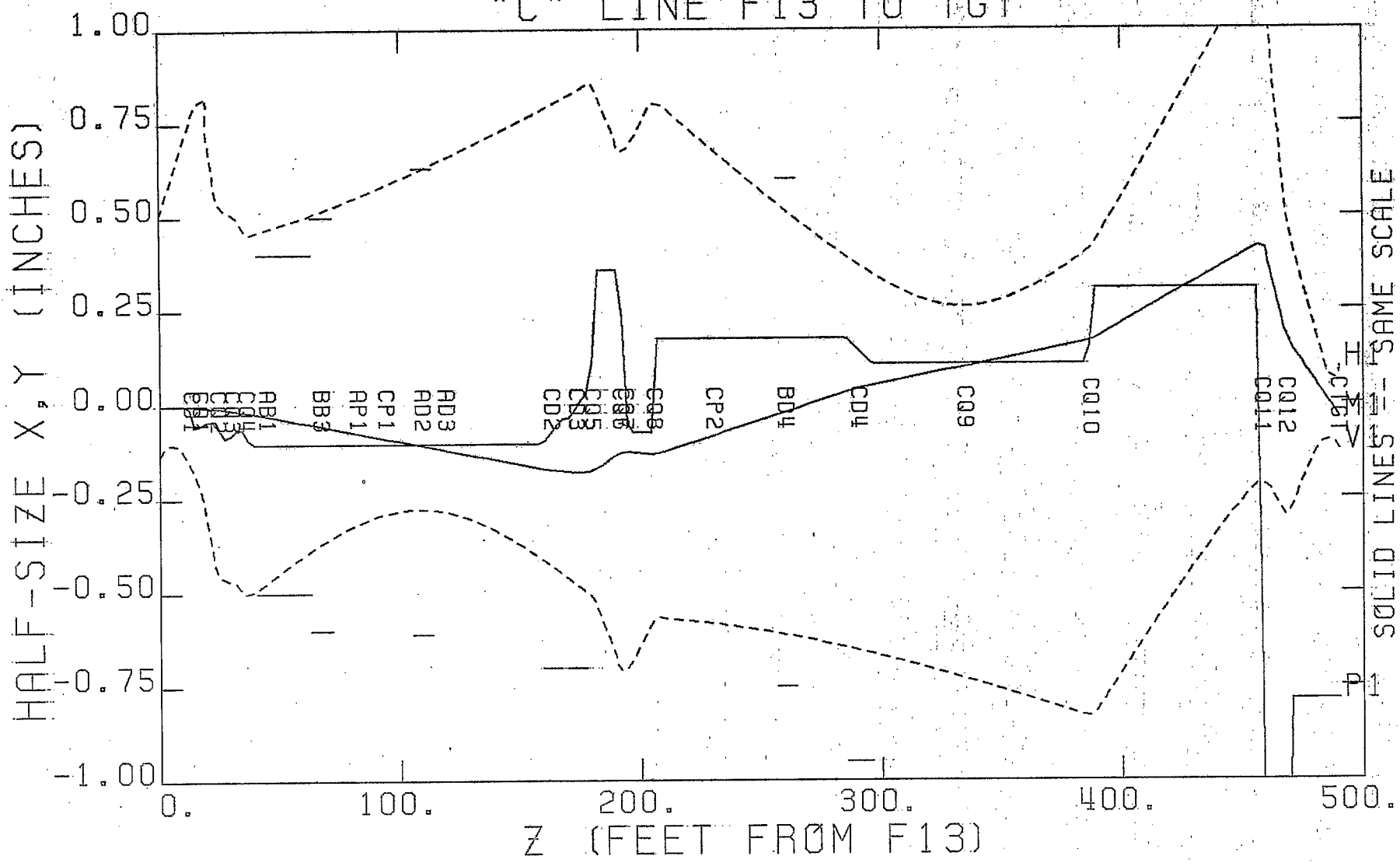
920

Figure 5B

BFILE	(BEAM FILE NUMBER; 1=A,2=B,3=C,4=D,5=U)	3
PBEAM	(BEAM MOMENTUM, GEV/C)	29.00
ABEF13	(ALPHA, BETA (KILOINCH), EPSILON (INCH-MRAD, RMS) AT F13)	
	HORIZONTAL: -6.3388 1.9952 0.0140	
	VERTICAL: 0.8708 0.1279 0.0150	
ABEH13	(ALPHA, BETA (KILOINCH), EPSILON (INCH-MRAD, RMS) AT H13)	
	HORIZONTAL: -5.6700 2.2620 0.0064	
	VERTICAL: 0.9870 0.1457 0.0064	
DFF	((DELTA P/P) OR MOMEN.FRACT:IN % FOR 99% BEAM)	0.0000
H13MOM	(INPUT HORIZ. MOMEN. DISPERSION AT H13; INCH/% ,MR/%)	
	-1.1650 -2.9500	
TEKVER	(=1 FOR TEKTRONIX PLOTS,=2(MODEL 1200) OR -2(MODEL 1100) VERSATEK 8 NO TUNING)	1
LFRAME	(=0 OR NEG. TO SUPPRESS FRAMES & LABELS ON GRAPHS; -1,0 OR 1 FOR ALL GRAPHS; -2 OR 2 FOR NO MOMEN. DISPERSION PLOTS)	1
IACSFC	(ACS FLAG;=1 FOR MAGNET VALUES FROM TTY,=2 FOR ACAST RDEKS,=3 FOR ACAST COMMANDS)	3
PSTIME	(POWER SUPPLY READ TIME IN MS AFTER T0)	1100
ZRANGE	(PLOTING RANGE IN BEAM LINE FEET (MIN,MAX))	
	0.000 (STARTING POINT OR 0 FEET FROM F13)	
	10000.000 (END POINT OR END OF BEAM LINE)	
IENUT	(0="ACAST" OR TTY; -1 = OFFLINE "ENUTQ")	0
TEGFC	(0=USE CURRENT "ENUTQ" "QTUNE.TEC" FILE;-1 TO CHANGE FILE NAME)	0
XYRANG	(MAX. BEAM HALF SIZE FOR PLOTING, INCH)	1.0000

Figure 6

"C" LINE F13 TO TGT



BS1
 CS1
 CS2
 CS3
 CS4
 CS5
 CS6
 CS7
 CS8
 CS9
 CP1
 CP2
 BD4
 CD4
 CO9
 CO10
 CO11
 CO12
 AD1
 AD2
 AD3
 AP1
 BB3
 CD2
 CD3
 CD5
 CD6
 CD7
 CD8
 CD9
 CP2
 BD4
 CD4
 CO9
 CO10
 CO11
 CO12

Figure 7

15-Jul-82 13:59

ORMS PARAMETERS:

ALPHA, BETA, EPSILON (H,V) AT F13: -6.3388 1.9952 0.0140 0.8708 0.1279 0.0150

CD1 (-2243)	CQ1 (-1898)	CQ2 (1073)	CQ3 (-303)	CQ4 (687)	CD283(3269)	CD283(3269)	CQ588(-1105)	CQ687(1000)	CQ687(1000)	C	
Q588(-1105)	CD4 (-2681)	CQ9 (1)	CQ10 (2658)	CQ11(-3502)	CQ12 (2390)	CD3T (0)					
CM%HZ	CM%HX	CM%VZ	CM%VX	CA%HI	CA%HO	CA%VI	CA%VO	CT%HZ	CT%HX	CT%VZ	CT%VX
-199.77	403.98	1296.98	277.03	-1858.70	2977.50	-1533.36	-162.67	-33.40	62.45	-56.59	95.35
BT%HZ	BT%HX	BT%VZ	BT%VX	AT%HZ	AT%HX	AT%VZ	AT%VX	BMDIV	TC%CH	TC%CV	
-1.00	62.00	3.00	32.00	854.00	224.00	-1592.00	127.00	86.52	93.04	125.76	

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ORMS PARAMETERS:

ALPHA, BETA, EPSILON (H,V) AT F13: -6.3388 1.9952 0.0140 0.8708 0.1279 0.0150

CD1 (-2243)	CQ1 (-1898)	CQ2 (1073)	CQ3 (-303)	CQ4 (687)	CD283(3269)	CD283(3269)	CQ588(-1105)	CQ687(1000)	CQ687(1000)	C	
Q588(-1105)	CD4 (-2681)	CQ9 (1)	CQ10 (2658)	CQ11(-3502)	CQ12 (2390)	CD3T (0)					
CM%HZ	CM%HX	CM%VZ	CM%VX	CA%HI	CA%HO	CA%VI	CA%VO	CT%HZ	CT%HX	CT%VZ	CT%VX
-199.77	403.98	1296.98	277.03	-1858.70	2977.50	-1533.36	-162.67	-33.40	62.45	-56.59	95.35
BT%HZ	BT%HX	BT%VZ	BT%VX	AT%HZ	AT%HX	AT%VZ	AT%VX	BMDIV	TC%CH	TC%CV	
-1.00	62.00	3.00	32.00	854.00	224.00	-1592.00	127.00	86.52	93.04	125.76	

Figure 8

	EQUIP	AREA	COMP	DEVTP	ADDR	WHO	WHRC	DEFINITION
1	AT%HX	SEB	(REFERENCE)					(HALF WIDTH(MILS) OF HORIZ. BEAM AT WAIST NEAR 'A' TGT. (QTUNE PGM.)
2	AT%HZ	SEB	(REFERENCE)					(Z POS. OF 'A' TGT. HORIZ. WAIST, INCH; 0='A' TGT.; -50=50 IN. UPSTRM 'A')
3	AT%VX	SEB	(REFERENCE)					(HALF WIDTH(MILS) OF VERT. BEAM AT WAIST NEAR 'A' TGT. (QTUNE PGM.)
4	AT%VZ	SEB	(REFERENCE)					(Z POS. OF 'A' TGT. VERT. WAIST, INCH; 0='A' TGT.; -50=50 IN. UPSTRM 'A')
5	BT%HX	SEB	(REFERENCE)					(HALF WIDTH(MILS) OF HORIZ. BEAM AT WAIST NEAR 'B' TGT. (QTUNE PGM.)
6	BT%HZ	SEB	(REFERENCE)					(Z POS. OF 'B' TGT. HORIZ. WAIST, INCH; 0='B' TGT.; -50=50 IN. UPSTRM 'B')
7	BT%VX	SEB	(REFERENCE)					(HALF WIDTH(MILS) OF VERT. BEAM AT WAIST NEAR 'B' TGT. (QTUNE PGM.)
8	BT%VZ	SEB	(REFERENCE)					(Z POS. OF 'B' TGT. VERT. WAIST, INCH; 0='B' TGT.; -50=50 IN. UPSTRM 'B')
9	CA%HI	SEB	(REFERENCE)					(1000 TIMES BEAM HORIZ. EMITTANCE ALPHA AT CQ5 UPSTREAM (Q TUNE USES))
10	CA%HO	SEB	(REFERENCE)					(1000 TIMES BEAM HORIZ. EMITTANCE ALPHA AT CQ8 DOWNSTREAM (Q TUNE USES))
11	CA%VI	SEB	(REFERENCE)					(1000 TIMES BEAM VERTICAL EMITTANCE ALPHA AT CQ5 UPSTREAM (Q TUNE USES))
12	CA%VO	SEB	(REFERENCE)					(1000 TIMES BEAM VERTICAL EMITTANCE ALPHA AT CQ8 DNSTREAM (Q TUNE USES))
13	CM%HX	SEB	(REFERENCE)					(HALF-WIDTH(MILS) OF HORIZ. BEAM AT WAIST MID 'C' LINE (Q TUNE PGM)
14	CM%HZ	SEB	(REFERENCE)					(Z POS. MIDDLE C LINE (INCH FROM F13) OF HORIZ. WAIST (Q TUNE PGM USES))
15	CM%VX	SEB	(REFERENCE)					(HALF-WIDTH(MILS) OF VERT. BEAM AT WAIST MID C LINE (Q TUNE PGM))
16	CM%VZ	SEB	(REFERENCE)					(Z POS. MIDDLE C LINE (INCH FROM F13) VERT. WAIST (Q TUNE PGM USES))
17	CT%HX	SEB	(REFERENCE)					(HALF WIDTH(MILS) OF HORIZ. BEAM AT WAIST NEAR 'C' TGT. (QTUNE PGM USES))
18	CT%HZ	SEB	(REFERENCE)					(Z POS. OF 'C' TGT. HORIZ. WAIST, INCH; 0='C' TGT.; -50=50 IN. UPSTRM 'C')
19	CT%VX	SEB	(REFERENCE)					(HALF WIDTH(MILS) OF VERT. BEAM AT WAIST NEAR 'C' TGT. (QTUNE PGM USES))
20	CT%VZ	SEB	(REFERENCE)					(Z POS. OF 'C' TGT. VERT. WAIST, INCH; 0='C' TGT.; -50=50 IN. UPSTRM 'C')
21	TC%AH	SEB	(REFERENCE)					(CALCULATED HORIZONTAL HALF WIDTH BEAM SIZE IN MILS AT "A" TARGET)
22	TC%AV	SEB	(REFERENCE)					(CALCULATED VERTICAL HALF WIDTH BEAM SIZE IN MILS AT "A" TARGET)
23	TC%BH	SEB	(REFERENCE)					(CALCULATED HORIZONTAL HALF WIDTH BEAM SIZE IN MILS AT "B" TARGET)
24	TC%BV	SEB	(REFERENCE)					(CALCULATED VERTICAL HALF WIDTH BEAM SIZE IN MILS AT "B" TARGET)
25	TC%CH	SEB	(REFERENCE)					(CALCULATED HORIZONTAL HALF WIDTH BEAM SIZE IN MILS AT "C" TARGET)
26	TC%CV	SEB	(REFERENCE)					(CALCULATED VERTICAL HALF WIDTH BEAM SIZE IN MILS AT "C" TARGET)
27	TC%UH	FEB	(REFERENCE)					(CALCULATED HORIZ. HALF WIDTH BEAM SIZE IN MILS AT U TGT. - QTUNE PGM)
28	TC%UV	FEB	(REFERENCE)					(CALCULATED VERT. HALF WIDTH BEAM SIZE IN MILS AT U TGT. - QTUNE PGM)
29	US%HD	FEB	(REFERENCE)					(1000 X CALC. MOMENTUM DISPERSION (INCH/RATIO) AT END OF 8 DEG. MAGNET)
30	US%MF	FEB	(REFERENCE)					(1000 X CALC. MOMENTUM DISPERSION PRIME (MR/RATIO) AT END OF 8 DEG. MA)
31	UT%HX	FEB	(REFERENCE)					(HALF WIDTH(MILS) OF HORIZ. BEAM AT WAIST NEAR TGT. - QTUNE PGM. USES)
32	UT%HZ	FEB	(REFERENCE)					(Z POS. OF U TGT. HORIZ. WAIST, INCH; 0=U TGT.; -50=50 IN. UPSTRM U TGT)
33	UT%VX	FEB	(REFERENCE)					(HALF WIDTH(MILS) OF VERT. BEAM AT WAIST NEAR TGT. - QTUNE PGM. USES)
34	UT%VZ	FEB	(REFERENCE)					(Z POS. OF U TGT. VERT. WAIST, INCH; 0=U TGT.; -50=50 IN. UPSTRM U TGT)

Figure 9

"C" LINE MAGNETS FROM F13 TO CTARGET

ELEMENT		MAGNET		#	Z(U/S) INCH	LENGTH INCH	XAPER INCH	YAPER INCH	POWER SUPPLY INFORMATION			
#	NAME LABEL	KIND	GROUP						DDF	PRIMARY AMPS/DCN	MAX KAMPS	SECONDARY DDF
1		DRIFT		0	0.000	143.825	0.000	0.000				
2	CD1	CD1	RDPOL 15C30	-7	143.825	34.350	1.440	1.440	CD1	0.6250	1.2.100	
3		DRIFT		0	178.175	8.075	0.000	0.000				
4	CQ1	CQ1	QUAD N3Q36	1	186.250	37.500	1.440	1.440	CQ1	0.7500	2.400	
5		DRIFT		0	223.750	46.500	0.000	0.000				
6	CQ2	CQ2	QUAD N3Q48	2	270.250	49.500	1.360	1.360	CQ2	1.0000	2.400	
7		DRIFT		0	319.750	20.500	0.000	0.000				
8	CQ3	CQ3	QUAD N3Q48	2	340.250	49.500	1.380	1.380	CQ3	1.0000	2.400	
9		DRIFT		0	389.750	26.500	0.000	0.000				
10	CQ4	CQ4	QUAD N3Q36	1	416.250	37.500	1.440	1.440	CQ4	0.7500	2.400	
11		DRIFT		0	453.750	33.125	0.000	0.000				
12	AB1	DRIFT		0	486.875	106.250	0.400	0.500				
13		DRIFT		0	593.125	163.750	0.400	0.500				
14	BB3	DRIFT		0	756.875	106.250	0.500	0.600				
15		DRIFT		0	863.125	68.750	0.000	0.000				
16	AP1	DRIFT		0	931.875	122.500	0.000	0.000				
17		DRIFT		0	1054.875	15.500	0.000	0.000				
18	CP1	DRIFT		0	1069.875	122.500	0.000	0.000				
19		DRIFT		0	1192.375	70.024	0.000	0.000				
20	AD2	DRIFT		0	1262.399	96.000	0.630	0.610				
21		DRIFT		0	1358.399	22.191	0.000	0.000				
22	AD3	DRIFT		0	1380.590	96.000	0.000	0.000				
23		DRIFT		0	1476.590	434.038	0.000	0.000				
24	CD2	CD2	RDPOL 5C90T	3	1910.623	91.500	0.000	0.700	CD283	0.3750	1.400	
25		DRIFT		0	2002.123	34.501	0.000	0.000				
26	CD3	CD3	RDPOL 5C90T	3	2036.629	91.500	0.000	0.700	CD283	0.3750	1.400	CD3T 0.1250
27		DRIFT		0	2123.129	24.650	0.000	0.000				
28	CQ5	CQ5	QUAD 4Q16	3	2152.779	17.200	1.690	1.690	CQ588	0.2500	0.406	
29		DRIFT		0	2169.979	124.800	0.000	0.000				
30	CQ6	CQ6	QUAD 4Q16	3	2294.779	17.200	1.690	1.690	CQ687	0.2500	0.406	
31		DRIFT		0	2311.979	6.800	0.000	0.000				
32	CQ7	CQ7	QUAD 4Q16	3	2313.779	17.200	1.690	1.690	CQ687	0.2500	0.406	
33		DRIFT		0	2335.979	124.800	0.000	0.000				
34	CQ8	CQ8	QUAD 4Q16	3	2460.779	17.200	1.690	1.690	CQ588	0.2500	0.406	
35		DRIFT		0	2477.979	229.150	0.000	0.000				
36	CP2	DRIFT		0	2707.129	122.500	0.000	0.000				
37		DRIFT		0	2829.629	248.897	0.000	0.000				
38	BD4	DRIFT		0	3073.526	92.500	0.600	0.750				
39		DRIFT		0	3171.026	256.120	0.000	0.000				
40	CD4	CD4	RDPOL D121	9	3427.146	123.500	1.000	0.950	CD4	0.3750	1.200	
41		DRIFT		0	3550.646	461.013	0.000	0.000				
42	CQ9	CQ9	QUAD 4Q16	3	4011.659	17.200	1.690	1.690	CQ9	0.0625	0.200	
43		DRIFT		0	4023.359	601.900	0.000	0.000				
44	CQ10	CQ10	QUAD 3Q32	4	4630.759	36.000	0.000	0.000	CQ10	0.3750	1.050	
45		DRIFT		0	4666.759	813.570	0.000	0.000				
46	CQ11	CQ11	QUAD N3Q36	1	5480.329	37.500	1.440	1.440	CQ11	0.3750	1.425	
47		DRIFT		0	5517.829	84.542	0.000	0.000				
48	CQ12	CQ12	QUAD N3Q36	1	5602.371	37.500	1.440	1.440	CQ12	0.7500	2.100	
49		DRIFT		0	5639.871	240.155	0.000	0.000				
50	CTGT	DRIFT		0	5880.026	0.000	0.000	0.000				

Figure 10

"C" LINE MAGNETS FROM T13 TO C.TARGET

ELEMENT		MAGNET		#	EFF. LEN INCH	KG/IN OR KG-IN POWER SERIES COEFFICIENTS FOR I IN KILOAMPS				MAX. MAGNET KAMPS	
#	NAME LABEL	KIND	GROUP			A0	A1	A2	A3		A4
1		DRIFT		0	143.825						
2	CD1	CD1	RDPOL 15C30	-7	34.350	1.6358793E+00	3.0900087E+02	1.5332217E+01	-7.0501699E+00	0.0000000E+00	2.4000
3		DRIFT		0	8.075						
4	CQ1	CQ1	QUAD N3Q36	1	37.500	1.5201630E-02	4.4772430E+00	1.9792940E-01	4.7379500E-02	-9.1596540E-02	2.6000
5		DRIFT		0	46.500						
6	CQ2	CQ2	QUAD N3Q48	2	49.500	1.5201630E-02	4.4772430E+00	1.9792940E-01	4.7379500E-02	-9.1596540E-02	2.6000
7		DRIFT		0	20.500						
8	CQ3	CQ3	QUAD N3Q48	2	49.500	1.5201630E-02	4.4772430E+00	1.9792940E-01	4.7379500E-02	-9.1596540E-02	2.6000
9		DRIFT		0	26.500						
10	CQ4	CQ4	QUAD N3Q36	1	37.500	1.5201630E-02	4.4772430E+00	1.9792940E-01	4.7379500E-02	-9.1596540E-02	2.6000
11		DRIFT		0	33.125						
12	AB1	AB1	DRIFT	0	106.250						
13		DRIFT		0	163.750						
14	BB3	BB3	DRIFT	0	106.250						
15		DRIFT		0	63.750						
16	AP1	AP1	DRIFT	0	122.500						
17		DRIFT		0	15.500						
18	CP1	CP1	DRIFT	0	122.500						
19		DRIFT		0	70.024						
20	AD2	AD2	DRIFT	0	96.000						
21		DRIFT		0	22.191						
22	AD3	AD3	DRIFT	0	96.000						
23		DRIFT		0	434.038						
24	CD2	CD2	RDPOL 5C90T	8	91.500	-9.8442070E-02	3.7920254E+02	5.6712130E+01	-2.1529536E+01	0.0000000E+00	3.5000
25		DRIFT		0	34.501						
26	CD3	CD3	RDPOL 5C90T	8	91.500	-9.8442070E-02	3.7920254E+02	5.6712130E+01	-2.1529536E+01	0.0000000E+00	3.5000
27		DRIFT		0	24.650						
28	CQ5	CQ5	QUAD 4Q16	3	17.200	1.1668710E-02	1.4303190E+01	1.9918540E+01	-8.3568380E+01	6.3286540E+01	0.5000
29		DRIFT		0	124.800						
30	CQ6	CQ6	QUAD 4Q16	3	17.200	1.1668710E-02	1.4303190E+01	1.9918540E+01	-8.3568380E+01	6.3286540E+01	0.5000
31		DRIFT		0	6.800						
32	CQ7	CQ7	QUAD 4Q16	3	17.200	1.1668710E-02	1.4303190E+01	1.9918540E+01	-8.3568380E+01	6.3286540E+01	0.5000
33		DRIFT		0	124.800						
34	CQ8	CQ8	QUAD 4Q16	3	17.200	1.1668710E-02	1.4303190E+01	1.9918540E+01	-8.3568380E+01	6.3286540E+01	0.5000
35		DRIFT		0	229.150						
36	CP2	CP2	DRIFT	0	122.500						
37		DRIFT		0	243.897						
38	BD4	BD4	DRIFT	0	92.500						
39		DRIFT		0	256.120						
40	CD4	CD4	RDPOL D121	9	123.500	4.3116340E+00	7.3160340E+02	-7.2491390E+02	3.0547750E+02	-3.0467400E+02	1.3000
41		DRIFT		0	461.013						
42	CQ9	CQ9	QUAD 4Q16	3	17.200	1.1668710E-02	1.4303190E+01	1.9918540E+01	-8.3568380E+01	6.3286540E+01	0.5000
43		DRIFT		0	601.900						
44	CQ10	CQ10	QUAD 8Q32	4	36.000	1.0087900E-03	1.2879310E+00	-4.5792080E-02	3.6950680E-02	-1.1821350E-02	3.3000
45		DRIFT		0	813.570						
46	CQ11	CQ11	QUAD N3Q36	1	37.500	1.5201630E-02	4.4772430E+00	1.9792940E-01	4.7379500E-02	-9.1596540E-02	2.6000
47		DRIFT		0	84.542						
48	CQ12	CQ12	QUAD N3Q36	1	37.500	1.5201630E-02	4.4772430E+00	1.9792940E-01	4.7379500E-02	-9.1596540E-02	2.6000
49		DRIFT		0	240.155						
50	CTGT	CTGT	DRIFT	0	0.000						

Figure 11

AGS Div. Tech. Note No. 181

*** HELP INFO. FOR TUNING QUADS ***

WHEN REQUESTED: GIVE 0,1,2,3,4,5,6, OR E ; PLOT MADE IF TUNING OK; ALL DEVICES ASSUMED CONSTANT EXCEPT THE QUADS.

- 0 --TYPE 0 AFTER VARYING QUADS--NEW WAIST PARAMETERS WILL BE FOUND AFTER READING ALL DEVICES.
- E --TYPE E TO LEAVE TUNING MODE.
- 1 --TYPE 1 -PGM READS "CN%??" WAIST PARAM. & FINDS NEW VALUES OF CQ1-4.
- 2 --PGM VARYS CQ5&6 AND CQ6&7 TO MAKE CA%HO=-CA%HI AND CA%VO =-CA%VI
- 3 --PGM READS ALL "CI%??" AND TUNES CQ9-12.
- 4 --PGM READS ALL "BT%??" AND TUNES BQ9-13.
- 5 --PGM READS "AT%??" AND TUNES AQ7&8 AND AQ9.
- 6 --PGM READS "UT%??" AND TUNES UQ11-14.

***NOTE: IF TUNING OK BUT POW. SUPPLY SATURATED, PLOT MADE BUT VALUES TYPED & NOT SENT TO AGAST: *2551* = SATUR. TO TUNE, MAKE SMALL CHANGES (LESS THAN 20).

TYPE <CR> TO CONTINUE