GEOMETRY OF THE BOOSTER INJECTION REGION

BOOSTER TECHNICAL NOTE
NO. 216

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January 6, 1993

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Alternating Gradient Synchrotron

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SUMMARY

This note details for easy reference the mechanical geometry of the Booster injection region, records some input parameters for MAD, and tries to suggest a standard context for modelling studies.

THE BOOSTER GEOMETRY

Booster Technical Note No. 164[1] tabulates the survey points of the Booster magnets. The layout principle of the Booster is very simple and is shown in Figure 1. A straight line, AB, enters a uniform magnetic field at point B. The field bends the beam through an angle, θ_1, of 10.000 degrees over an arc length, BF, of 2.420 meters. The beam leaves the field at point F and proceeds along the straight line FG. The survey points 1, 2, 3, and 6, 7, 8 represent the survey points at the center of the sextupoles and at the upstream and downstream ends of the quadrupoles. For the injection region C-5, Table 1 lists these points.

Since a real magnet is not hard edged but has complicated fringe fields, the detailed geometry becomes a little more subtle as shown in Figure 2. Booster Technical Note No. 163[2] works out the details, the net effect of which is to displace the dipole radially outward by 0.007 inches. This has no great practical effect but appears when we carry the survey calculations to high accuracy. Points 4 and 5 are the survey points of the dipole at the ends of the laminations. Points B, C, E, and F lie along the geometrical arc defined above. The survey points are listed in Table 1 and other parameters are listed in Table 2.

THE LTB GEOMETRY

The Linac-to-Booster Line (LTB) was originally laid out following the design manual but after the initial Booster run in the Spring of 1991, it was realigned in the Fall of 1991 as described in Booster Technical Note No. 203[3]. (The original layout is described in Booster Technical Note No. 160[4], which no longer applies.) Figure 3 shows the LTB line incident on the C-5 magnet. The straight line HI is determined by the survey points 9, 10, 11, 12, and 13 which are quadrupole centers and are listed in Table 1. Point L is the intersection of the projection of the line HI with the magnet chord 4-5. Some derived parameters are listed in Table 2. The last three items in Table 2 are from tape measurements of the installed equipment.[5]

The injected beam follows a path, IJ, through the magnet and emerges along the line JK. The important question for injection is determining the line JK either by tracking through the magnet, C-5, or by experiment. Subsequent notes will describe both of these efforts.

Appendix I shows the geometry in the AGS coordinate system and includes formulas for the various lines.

REFERENCES

1. Booster Technical Note No. 164, Design & First Control Survey of the Booster Monument Network and Modified Survey Marker Coordinates for the Booster Ring Magnets, M.A. Goldman, F.X. Karl, R.E. Thern, May 16, 1990.

2. Booster Technical Note No. 163, Booster Dipole Magnet Half-Cell Alignment including Magnet Fringe Field Effects, M.A. Goldman, April 16, 1990.

3. Booster Technical Note No. 203, Repositioning of the Linac to Booster Transport Line, F.X. Karl and M.A. Goldman, November 20, 1991.

4. Booster Technical Note No. 160, The October 1989 Survey of the Linac to Booster Transport Beam Line, F.X. Karl and M.A. Goldman, January 29, 1989.

5. E. Auerbach and E. Bleser, December 21, 1992.

TABLE 1
SURVEY POINTS FROM BTN 164 AND 203

NO.	SURVEY POINT	NORTH METERS	EAST METERS
1	SC5	381.16545	−0.63752
2	QC5.US	381.47670	−0.75533
3	QC5.DS	381.88648	−0.91043
4	DC5.US	382.23632	−1.04273
5	DC5.DS	384.46441	−1.67035
6	SC6	385.19266	−1.80847
7	QC6.US	385.52588	−1.87162
8	QC6.DS	385.94388	−1.95084
9	QV9	372.89434	−0.77404
10	QH10	375.18916	−0.92831
11	QV11	376.48623	−1.01550
12	QH12	378.78102	−1.16977
13	QV13	380.87631	−1.31062

TABLE 2
INPUT AND DERIVED GEOMETRY PARAMETERS

INPUT

BEND ANGLE	10.000000		DEGREES
	0.174533		RADIANS
ARC LENGTH B–F	2.420000		METERS
CHORD 4–5	2.314800		METERS

CALCULATED POINTS

NAME	NORTH	EAST		
B	382.18829	–1.02485		METERS
C	382.23625	–1.04290		METERS
E	384.46435	–1.67052		METERS
F	384.51468	–1.68015		METERS
I	382.05025	–1.38954		METERS
L	383.91177	–1.51468		METERS

DERIVED

BENDING RADIUS	13.86558		METERS
CHORD B–F	2.41693		METERS
CHORD B–C	0.05125		METERS
CHORD C–E	2.31480		METERS
CHORD E–F	0.05125		METERS
LINE C–4	0.00018		METERS
LINE E–5	0.00018		METERS
ANGLE THETA 2	0.16714		RADIANS
	9.57630		DEGREES
ANGLE THETA 3	0.29471		RADIANS
	16.88554		DEGREES
ANGLE THETA 4	0.20745		RADIANS
	11.88573		DEGREES
LINE B–I	0.38994		METERS
LINE 13–I	1.17659		METERS
LINE DV112–I	0.82774		METERS
LINE DH115–I	0.24949		METERS
LINE F–INJFOIL	0.27260		METERS

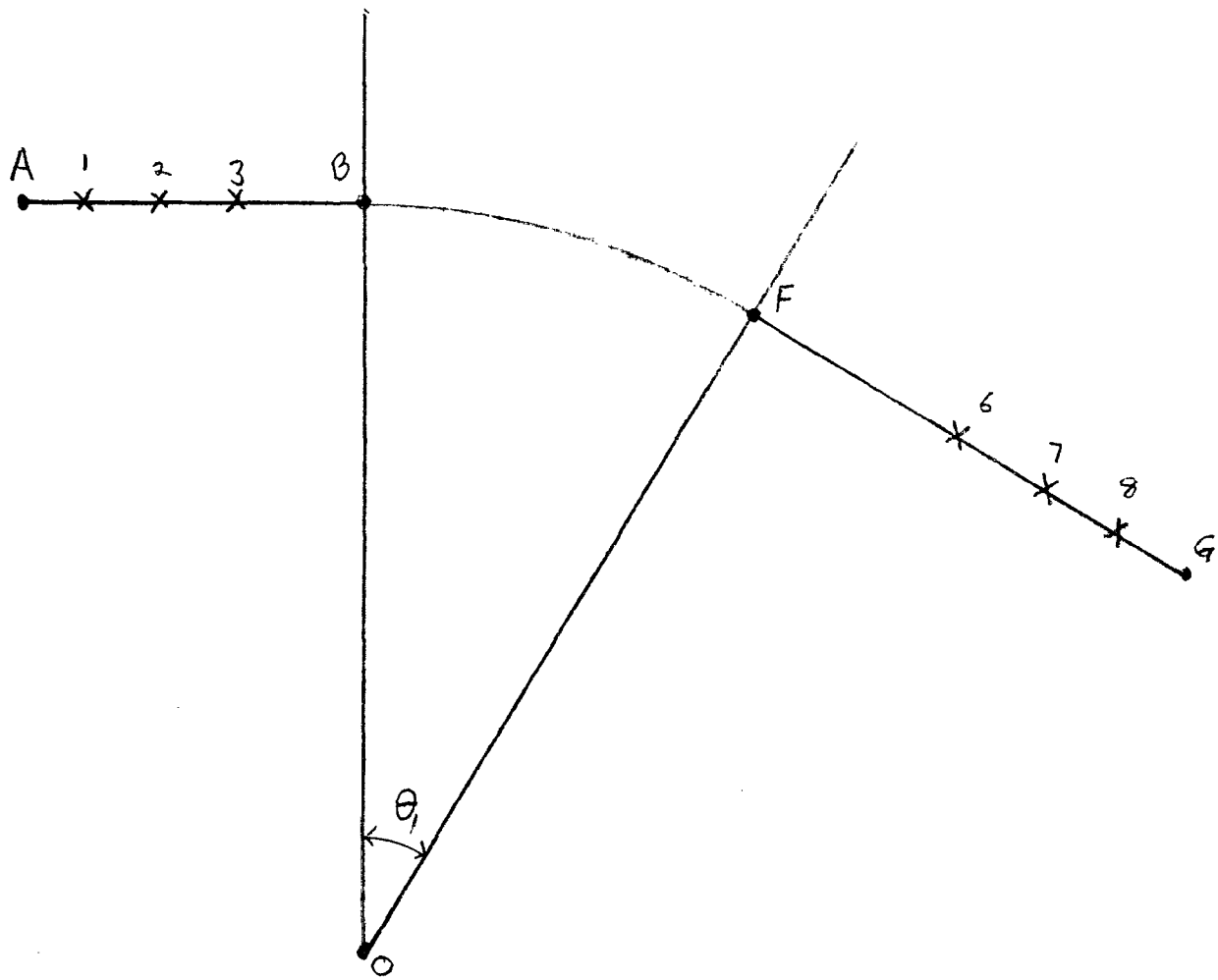


Figure 1

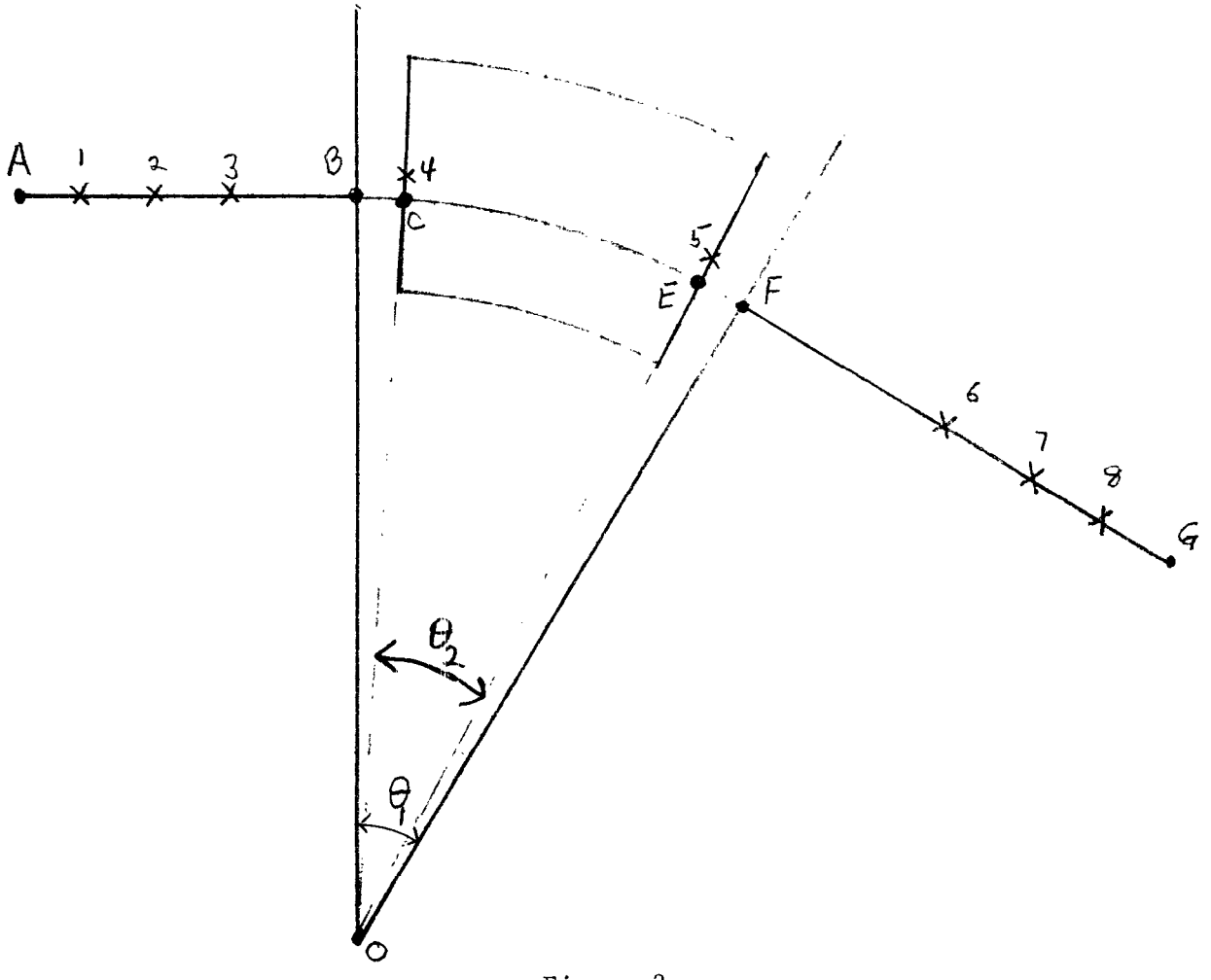


Figure 2

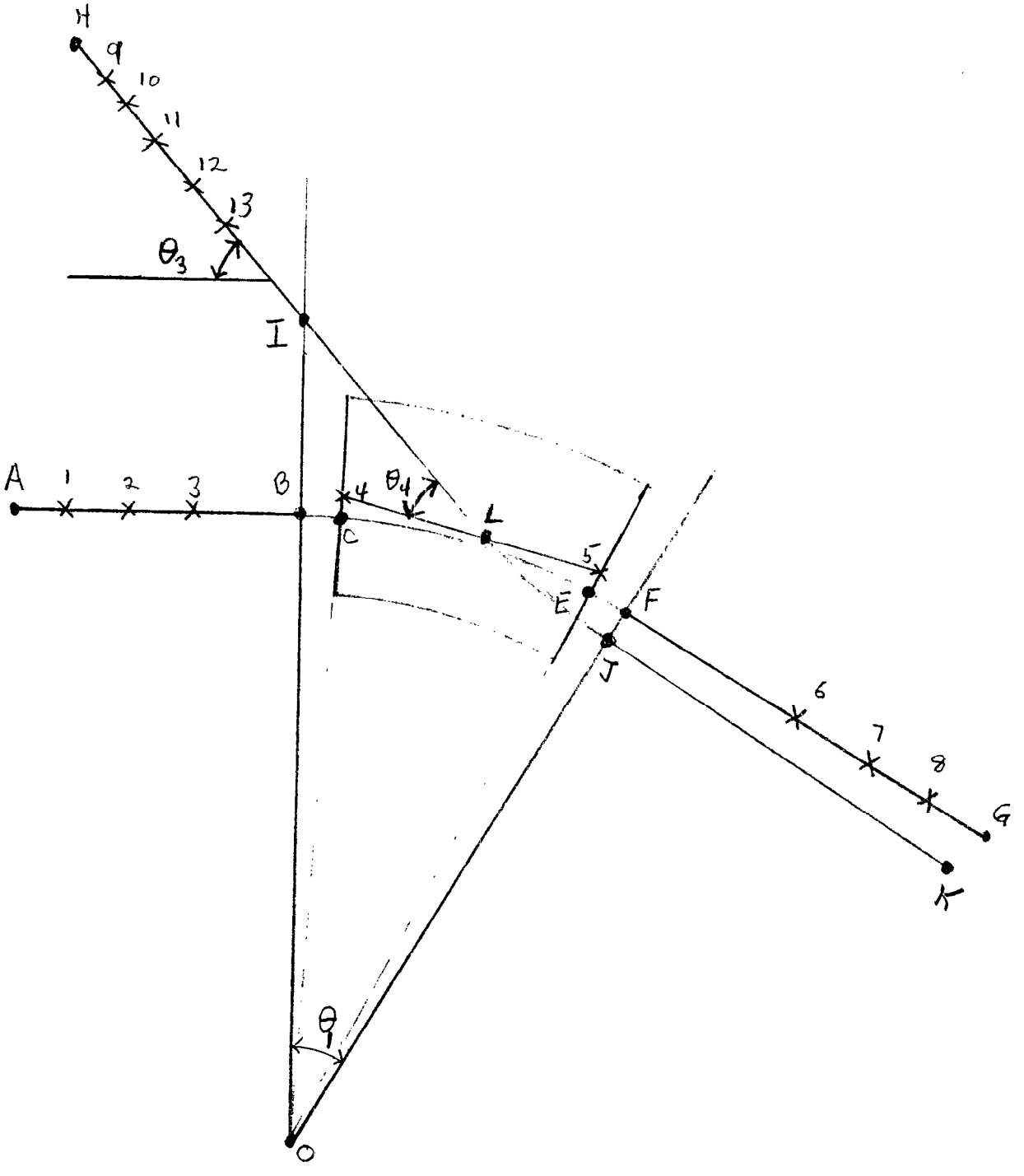
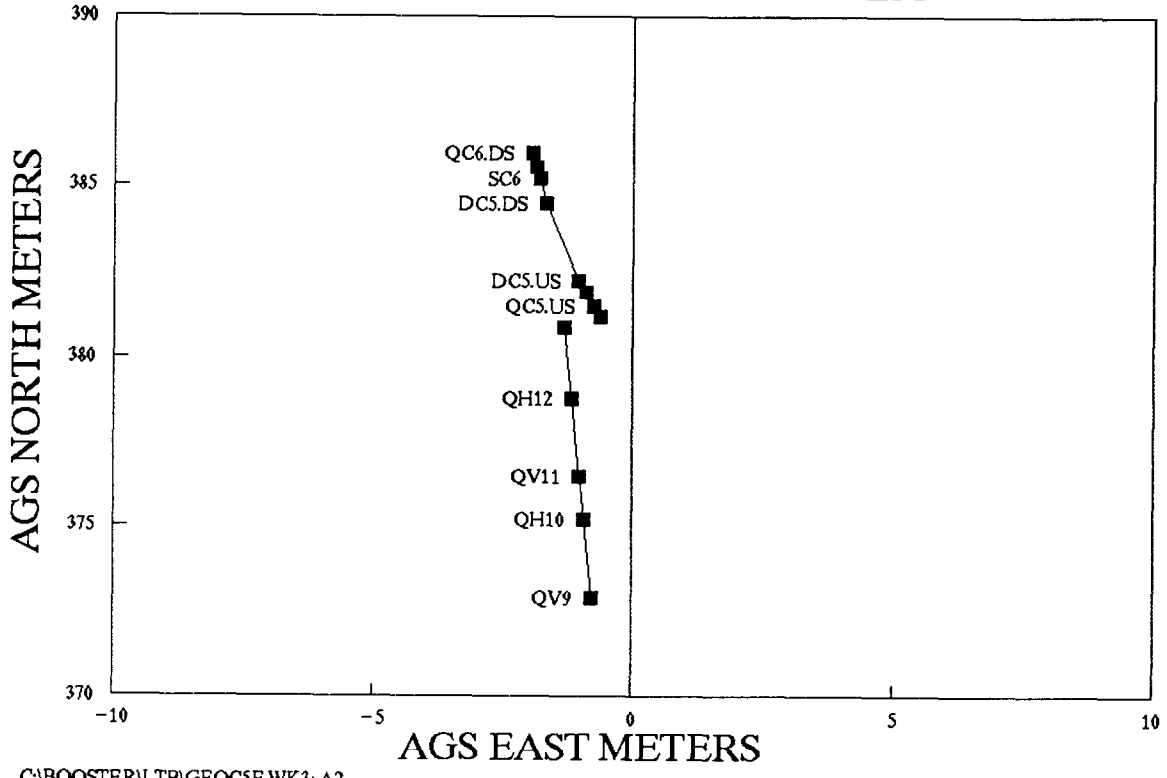


Figure 3

APPENDIX I

BOOSTER INJECTION REGION

IN AGS COORDINATE SYSTEM



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DEC. 31, 1992

LTB LINE [HI]	N =	361.3799	−14.8757 *E
INPUT LINE [AB]	N =	379.4811	−2.64205 *E
MAGNET LINE [45]	N =	378.5345	−3.5501 *E
OUTPUT LINE [FG]	N =	375.6502	−5.27651 *E