UPC No. 145
March 30, 1981

Fermilab

GEOMETRY OF LONG STRAIGHTS

S. Ohnuma

March 30, 1981

I. Introduction

The geometry given here is based on two reports, TM-1032 ("The Revised Great Doubler Shift") and a hand-written note by H. Edwards. The latter specifies the overall slot size of all quadrupoles and spools. It also shows the arrangement of various elements in long straights. This arrangement is used here without any change. The particular arrangement for the CØ long straight with six Lambertson magnets is based on the conversation I had with Frank Turkot. It is meant to be a possible version, not the only solution or the optimum arrangement. The intention here is to present a system from which we can work out a better one.

Main Ring Stations

Main ring stations used to specify the (X, Y) coordinates of various elements are those originally defined by Tom Collins (and interpreted by me):

1. regular stations (all except #11, #12, #17, #48 & #49)
   96" from the end of upstream dipole slot, 71.002" from the beginning of downstream dipole slot. See page 1 of TM-1032.
2. station #17 (medium straight)
   96" from the end of dipole #16-5 slot, 572.957" from the beginning of dipole #17-4 slot. See page 2 of TM-1032.

3. station #11 (old station #1) and station #49 (old #34)
   1182" from the station Ø.
4. station #12 (old #2)
   63.95" from the end of dipole #11-5 slot, 71.002" from the beginning of dipole #12-2 slot. See page 5 of TM-1032.
5. station #48 (old #33)
   96" from the end of dipole #47-5 slot, 322.002" from the beginning of dipole #48-3 slot. See page 4 of TM-1032.

Quadrupoles (as specified by H. Edwards)

1. 66F & 66D: slot length = 91" with H. or V. detector.
   all regular stations (including #17).
2. 32F & 32D: slot length = 56.97" with H. or V. detector.
   stations #48 and #12 of normal long straights.
3. 25F & 25D: slot length = 50.4" with H. or V. detector.
   stations #48 and #12 of high-beta long straights.
4. 82F & 82D: slot length = 109.81" with H. detector.
   normal long straights, matching outer doublet.
5. 90F & 90D: slot length = 115.09" with H. detector.
   high-beta long straights, matching outer doublet.
6. 99F & 99D: slot length = 113.3", no detector.
   all long straights, matching inner doublet.

Spools (as specified by H. Edwards)

1. 72S: slot length = 72" (should be 72.002" according to TM-1032)
   standard long spool at all regular stations and at #12.
2. 43S: slot length = 43"
   standard short spool at station #48.
3. 50S: slot length = 49.91"
   special spool placed after 82F & D, 90F & D.

II. Distance of Various Elements along the Beam Line

A. Doubler Long Straights AØ, BØ, DØ, EØ, FØ

The distance Z along the beam line is measured from the main ring station Ø. All numbers are in inches. Numbers and elements in parenthesis are for the high-beta long straights AØ and DØ.

Z	
-2525.101 (-2525.098)	*interface (end of dipole #47-5 slot) #48-1, 32F (25F) with H. detector.*
-2468.131 (-2474.698)	*43S, standard short spool.*
-2425.131 (-2431.698)	*possible warm drift space from -2410.131 to -2174.034 (from -2416.698 to -2182.790)*
-2164.034 (-2172.790)	*interface (beginning of dipole #48-3 slot) #48-3, 4, 5; three dipoles, 252" each.*
-1408.034 (-1416.790)	*interface (end of dipole #48-5 slot) 82F (90D) with H. detector.*
-1298.224 (-1301.700)	*50S, special spool with V. detector.*
-1248.314 (-1251.790)	*possible warm drift space from -1233.314 to -1173.954 (from -1236.790 to -1173.950)*
-1163.954 (-1163.950)	*99D (99F)*
-1050.654 (-1050.650)	*upstream half of long straight drift, warm from -1035.654 to Ø (from -1035.650 to Ø),*
0.000	*main ring station Ø.*

z	
0.000	*main ring station Ø.*
	downstream half of long straight drift, warm from Ø to 1019.664 (to 1019.660).
1029.664	
(1029.660)	*99F (99D)*
1142.964	
(1142.960)	*possible warm drift space from 1157.964 to 1258.424 (from 1157.960 to 1259.710).*
1268.424	
(1269.710)	*82D (90F) with H. detector.*
1378.234	
(1384.800)	*50S, special spool with V. detector.*
1428.144	*interface (beginning of dipole #11-2 slot)*
(1434.710)	*#11-2, 3, 4, 5; four dipoles.*
2436.144	*interface (end of dipole #11-5 slot)*
(2442.710)	*#12-1, 32D (25D) with V. detector.*
2493.114	
(2493.110)	*72S, standard long spool.*
2565.116	*interface (beginning of dipole #12-2 slot)*
(2565.112)	

B. Doubler Long Straight CØ

There are six Lambertson magnets for beam abort. The slot sizes assumed here are: 207" for L1 to L4, 135.4" for L5 and L6. The half-size dipole HB is assumed to have a slot of 131.5" (= 11" + 241"/2). The bend angle is $1.003\theta_B/6$ each for L1 to L4 and $0.994\theta_B/6$ for L5 and L6 ($\theta_B = 2\pi/774$).

z	
-2525.147	*interface*
	#48-1, 32F with H. detector.
-2468.177	
	43S, standard short spool.

Z

-2425.177 .....

kickers for beam abort.

-2043.580 ..... interface (beginning of dipole #48-3 slot)

#48-3 (HB), 4, 5.

-1408.080 ..... interface (end of dipole #48-5 slot)

82F, 50S, possible warm drift space, 99D.

-1050.700 .....

free space

-850.013 .....

Lambertsons L1 to L3.

-229.013 .....

free space

47.987 .....

Lambertsons L4 to L6.
F. Turkot believes that it is desirable to have a space of at least 4' between station Ø and L4.

525.787 .....

free space

1029.685 .....

99F, possible warm drift space, 82D, 50S.

1428.165 ..... interface (beginning of dipole #11-2 slot)

#11-2, 3 (HB)

1811.665 ..... interface

free space

1932.165 ..... interface

#11-4, 5

2436.165 ..... interface

#12-1, 32D

2493.135 ..... interface

72S, standard long spool.

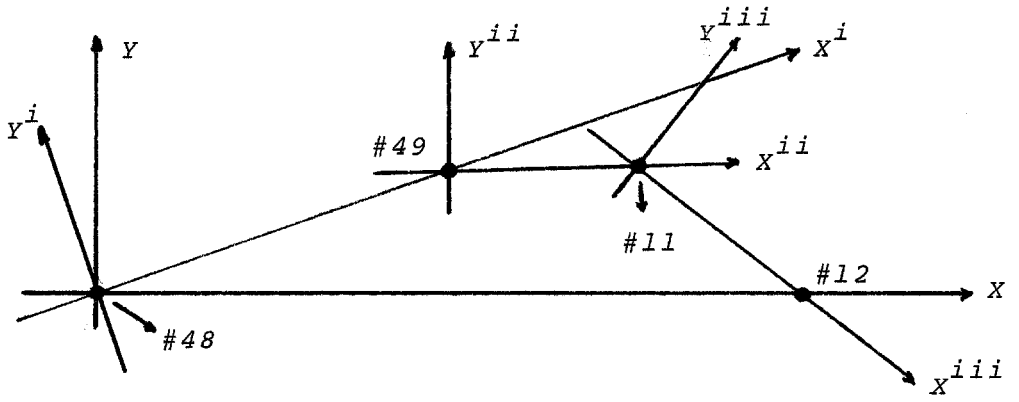
2565.137 ..... interface (beginning of dipole #12-2 slot)

III. The (X, Y) Coordinates of Elements

X-axis: the line from main ring station #48 to station #12.
Y-axis: perpendicular to X-axis, pointing outward.

(X^i, Y^i) system: use stations #48 and #49 instead of #48 and #12.

(X^{ii}, Y^{ii}) system: use stations #49 and #11.
(X^{iii}, Y^{iii}) system: use stations #11 and #12.



distance		
	#48 to #12	4926.8475"
	#48 to #49	1233.5610"
	#49 to #11	2364"
	#11 to #12	1329.5304"

transformation

i) $X^i = c^i X + s^i Y, \quad s^i = .014\ 066\ 252$

$Y^i = -s^i X + c^i Y, \quad c^i = .999\ 901\ 065$

ii) $X^{ii} = c^{ii} X + s^{ii} Y - 1233.4438$

$Y^{ii} = -s^{ii} X + c^{ii} Y - 17.0097$

$c^{ii} = .999\ 999\ 962, \quad s^{ii} = .000\ 277\ 177$

iii) $X^{iii} = c^{iii} X - s^{iii} Y - 3596.8652, \quad c^{iii} = .999\ 908\ 279$

$Y^{iii} = s^{iii} X + c^{iii} Y - 66.7280, \quad s^{iii} = .013\ 543\ 744$

A. Main Ring Long Straights

For dipoles, two ends and the center of each slot are given.

	X	Y	
station #48	0.000	0.000	
	321.904	7.9303	
#48-3	447.372	10.7665	
	572.851	13.0934	
#48-4	698.337	14.9110	
	823.830	16.2193	
#48-5	949.328	17.0181	
	1074.827	17.3076	
station #49	1233.439	17.3516	
station #Ø	2415.439	17.6792	
station #11	3597.439	18.0068	
	3859.102	18.0793	
#11-2	3984.602	17.8594	
	4110.100	17.1301	
#11-3	4235.594	15.8915	
	4361.082	14.1434	
#11-4	4486.561	11.8861	
	4612.031	9.1194	
#11-5	4737.488	5.8435	
	4862.931	2.0585	
#12-1	4894.889	1.0292	(quadrupole center)
station #12	4926.8475	0.0000	

B. Doubler Normal Long Straights BØ, EØ, FØ

Again two ends and the center of each dipole slot are shown. Coordinates of the support points (= center±71") are available upon request.

	X	Y
	251.487	6.3365
#48-3	377.454	9.2382
	503.431	11.6285

	X	Y
	503.431	11.6285
#48-4	629.417	13.5075
	755.409	14.8751
#48-5	881.406	15.7313
	1007.406	16.0761
82F, center	1066.903	16.118
99D, center	1308.323	16.289
99F, center	3501.940	17.840
82D, center	3743.360	18.010
	3843.583	18.0812
#11-2	3969.583	17.9146
	4095.581	17.2365
#11-3	4221.575	16.0471
	4347.564	14.3462
#11-4	4473.544	12.1340
	4599.515	9.4105
#11-5	4725.473	6.1757
	4851.417	2.4296
32D, center	4885.572	1.3444
station #12	4926.849	0.0328

C. Doubler High-Beta Long Straights AØ, DØ

	X	Y
	242.731	6.1171
#48-3	368.698	9.0187
	494.675	11.4090
#48-4	620.661	13.2880
	746.653	14.6556
#48-5	872.650	15.5118
	998.650	15.8566
90D, center	1061.882	15.901
99F, center	1308.327	16.076
99D, center	3501.936	17.626
90F, center	3748.381	17.801

	X	Y
	3850.149	17.8726
#11-2	3976.149	17.9614
	4102.147	17.0279
#11-3	4228.141	15.8384
	4354.130	14.1376
#11-4	4480.110	11.9254
	4606.081	9.2018
#11-5	4732.039	5.9670
	4857.983	2.2210
25D, center	4888.855	1.2401
station #12	4926.848	0.0328

D. Doubler Abort Long Straight CØ

	X	Y
	371.949	9.3560
#48-3 (HB)	437.680	10.9368
	503.414	12.3843
#48-4	629.392	14.7746
	755.378	16.6536
#48-5	881.370	18.0212
	1007.367	18.8774
82F, center	1066.863	19.161
99D, center	1308.281	20.312
	1565.428	21.5371
L1	1668.927	21.9953
	1772.566	22.3832
L2	1875.926	22.7009
	1979.426	22.9484
L3	2082.926	23.1256
	2186.426	23.2326
	2463.426	23.4251
L4	2566.926	23.4619
	2670.426	23.4285
L5	2738.126	23.3609
	2805.825	23.2477
L6	2873.525	23.0891
	2941.225	22.8849
99F, center	3501.956	21.005
82D, center	3743.375	20.196

	X	Y
	3843.597	19.8602
#11-2	3969.596	19.1822
	4095.590	17.9927
#11-3 (HB)	4161.335	17.1719
	4227.078	16.2176
	4347.563	14.3465
#11-4	4473.544	12.1343
	4599.514	9.4108
#11-5	4725.473	6.1760
	4851.417	2.4299
32D, center	4885.572	1.3447
station #12	4926.849	0.0331

At the upstream end of 99F (Z = 1029.685), the separation of two beams (aborted and normal) is 9.30":

aborted beam	Y = 30.495"
normal beam	Y = 21.196"