AGS BOOSTER GEOMETRY and COORDINATES

AD

Booster Technical Note
No. 100

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November 1987

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AND

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ABSTRACT

Booster coordinates are generated in the Machin centered frame. Transformation from the Booster centered frame to the AGS and BNL grids are reviewed, and the coordinates of the Booster with respect to these frames are tabulated. This updates the AGS Booster coordinates given in the Booster Design Manual and Booster Technical Note Number 27.

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I. INTRODUCTION

This note updates the coordinates of the Booster, calculated using VAX version of the Geometry program for the Booster (which we will refer to as BSTGEO.FOR). Since the CDC7600 is retired and no longer available at BNL. The coordinates obtained (given in Table II and III) agrees with and confirms the previous results (obtained with the CDC version of this program); with a change in sextupole coordinates. Since here (e.g. Table I), not only we used thick lens sextupoles of length = .1 m (instead of the thin lens sextupoles of zero length, previously [1] used) but also some corrections was made in the VAX version of BSTGEO.FOR, resulting in more accuracy (in the calculation) of the sextupole coordinates.

In section II, the booster centered reference system and in section III the transformation to the AGS and BNL grids are reviewed. The coordinates of the Booster with respect to these frames are tabulated with the same element labling conventions we used in the Booster Design Manual to facilitate the updating of the Design Manual.

Additionally, reference angle Alpha is defined in section IV; monuments and markers are discussed in section V, and magnet missalignment errors and closed orbit corrections are given in a subsequent note.

Alternatively, the Booster coordinates were generated using the program MAD [3]; and the result obtained [5] agree and confirm the result we obtained with program BSTGEO.FOR, given in Tables II and III.

Figures 1 - 7 are also included, showing angle Alpha, AGS and the proposed ISABEL Markers (on the magnets) and the layout of the Booster and relative position of the labling convention of the Booster lattic [4] and its superperiods.

II. BOOSTER CENTERED REFERENCE SYSTEM

The coordinates of the Booster lattice [4] in the Booster centered reference system, (with East (as X) and North (as Y) axes where the length is measured in meters) were generated in two ways on the VAX780; (Assuming that the magnets have sharp edges where the field becomes zero.)

1) With program MAD versions 4.03 and 6 (both versions produced the same results [5]);

2) Using tape 15 of program SYNCH [7] and BSTGEO.FOR.

The values listed in Table II and III corresponds to the coordin-

ates of the apex of the dipoles and centers of the quadrupoles and sextupoles in the Booster centered frame and the AGS grid respectively.

These coordinates (given in Tables II and III) agrees with and confirm our previous results [1, 5], we obtained with a CDC - version of the Geometry program [2].

In the present calculation (shown in Table I) we used thick lens sextupoles of length .1 m; whereas in reference [5] thin lens sextupoles of zero length were assumed.

The transformation from the Booster centered reference system to the AGS and BNL grids are reviewed in the next section.

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The transformation from the Booster centered reference system to the AGS and BNL grids are reviewed in the next section.

III. TRANSFER OF COORDINATES TO AGS AND BNL GRIDS

Following is an overview of the transformation from the Booster centered frame of reference to that of AGS and BNL grids asuuming that the axes of the Booster centered coordinate system are parallel to those of I) AGS and II) BNL grids. This transformations which was included in our previous notes [1] remain unchanged although the coordinates given in Tables I-III updates the the previous values given in Ref. [1].

Note, the X and Y are the x and y distances expressed in the Booster coodinate system. Where the E (EAST) and N (North) coordinates and E0 and N0 are the the coordinates of the Booster in the AGS [E(inch),N(inch)] and BNL [E(feet),N(feet)] grids respectively.

I. AGS GRID

$$E(\text{inch}) = E0_{AGS}(\text{inch}) + X_{BST}(\text{inch})$$

$$N(\text{inch}) = N0_{AGS}(\text{inch}) + Y_{BST}(\text{inch})$$

with $E0_{AGS}(\text{inch}) = 1{,}148.88$ and $N0_{AGS}(\text{inch}) = 15{,}459.36$

II. BNL GRID

$$E(\text{feet}) = E0_{BNL}(\text{feet}) + X_{BST}(\text{feet})$$

$$N(\text{feet}) = N0_{BNL}(\text{feet}) + Y_{BST}(\text{feet})$$

With $E0_{BNL}(\text{feet}) = 98{,}517.19$ and $N0_{BNL}(\text{feet}) = 102{,}438.28$.

Values of E0 and N0 were obtained from P. Mohn [4], Note that the origins of the two systems are different and the conversion factor used is 2.54 cm/inch).

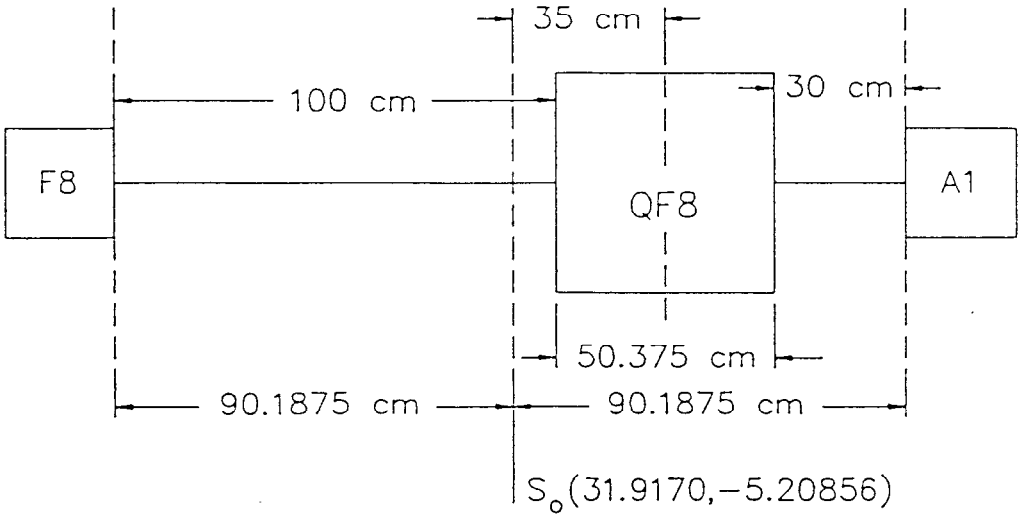


Figure 1 . Relationship between quadrupole at F8 and dipole at A1.

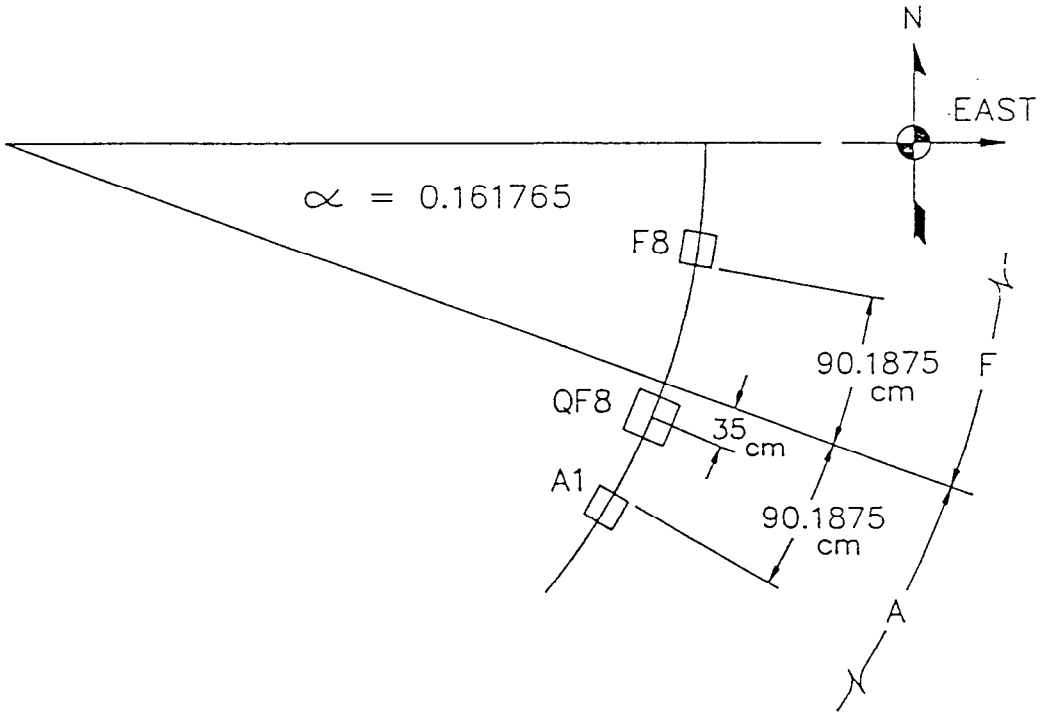


Figure 2 . The angle α.

IV. Reference Angle α

Angle Alpha (α) is the angle between the x-axis (east) and the line joining the center of the Booster to the point between F8 and A1 superperiods (where α = 0.161765 radians, see Figures 1 and 2). This reference angle is used to preserve the AGS system of labeling, that the quadrupole following the dipole gets its name from that dipole.

V. ON THE MONUMENTS AND THE MARKERS

Following are the information I have received from P. Mohn On the monuments for the Booster ring:

> Base line and bench mark survey control will be established by the AGS - Survey Group. From this (field control) the contractor will establish working points in the field for the Booster conventional construction (Tunnel).
>
> At the completion of this construction permanent monuments will be established throughout the tunnel by BNL - AGS survey Group.

Thus, the surveyers are to determine the number and locations of the monuments around the ring.

Further, we recommend and note that the decesion on the locations of the markers on the magnets should be made such that cables and equipments would not interfere with markers visibility. Possible schemes would be similar to those used in AGS (e.g. Figure 3) or that which was proposed for ISABEL (e.g. Figure 4), [6].

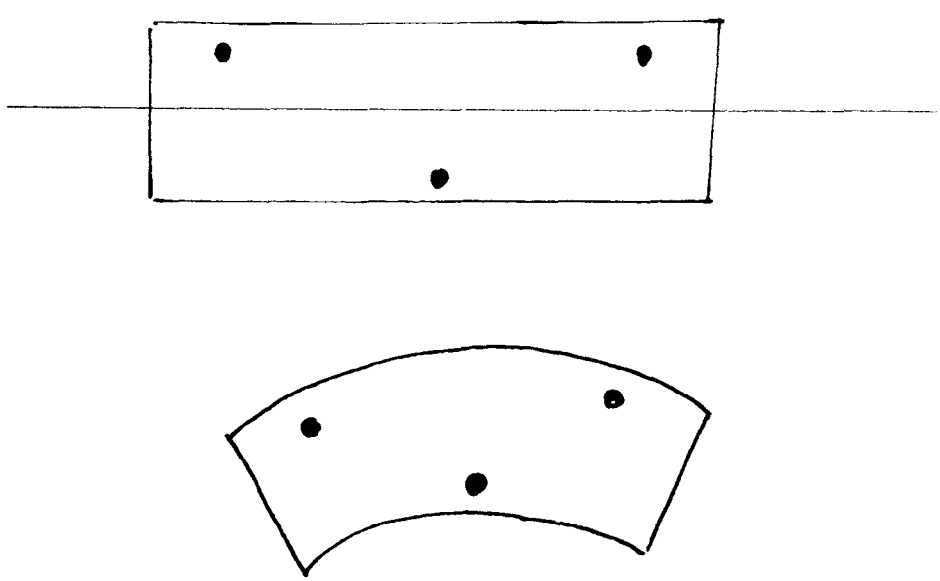
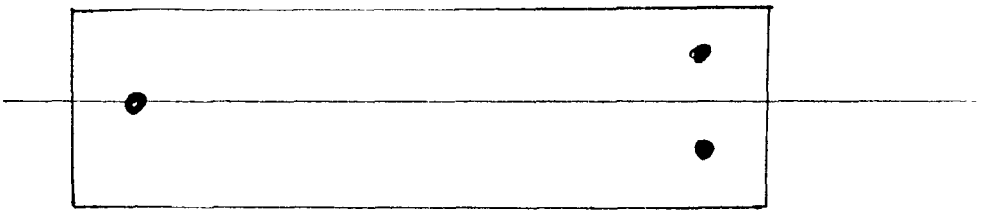
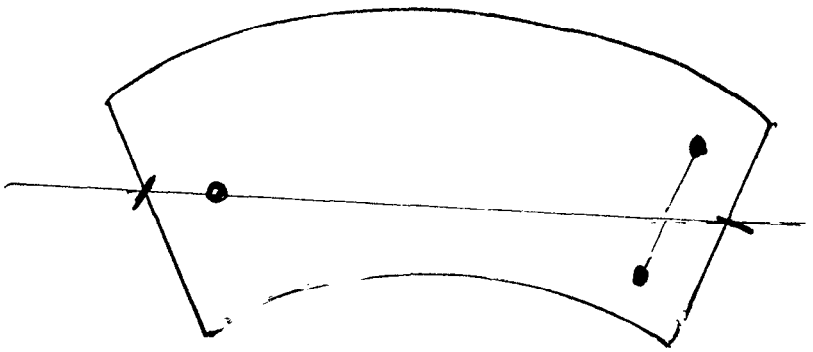


FIGURE 3 ; SAMPLE AGS MARKERS



(SAMPLE PROPOSED ISABEL MARKERS)



VI. CONCLUSION

The coordinates of the Booster were generated. The result obtained agree with and confirms our previous calculation given in the Booster Design Manual with a change in the coordinates of the sextupoles. The transformations from the Booster centered reference system to AGS and BNL grids was reviewed and the coordinates of the apex of the dipoles and centers of the quadrupoles and sextupoles in these referece frames are tabulated.

VII. REFERENCES

1. Z. Parsa, Booster Technical Note No. 27 and; Booster Desing Manual.

2. Originally was designed for ISABEL (E. Courant). Now modified for the Booster (I refer to it as) BSTGEO.FOR (VAX version), and a version we use for the RHIC coordinate calculation, (will be refered to as) GEOMETRY.FOR (also VAX version).

3. F. C. Iselin, CERN, Geneva, Switzerland, Principle author of program MAD (versions 4 and 6).

4. E. Courant, Z. Parsa, Booster Lattice, Booster Technical Note No. 1; January 1986.

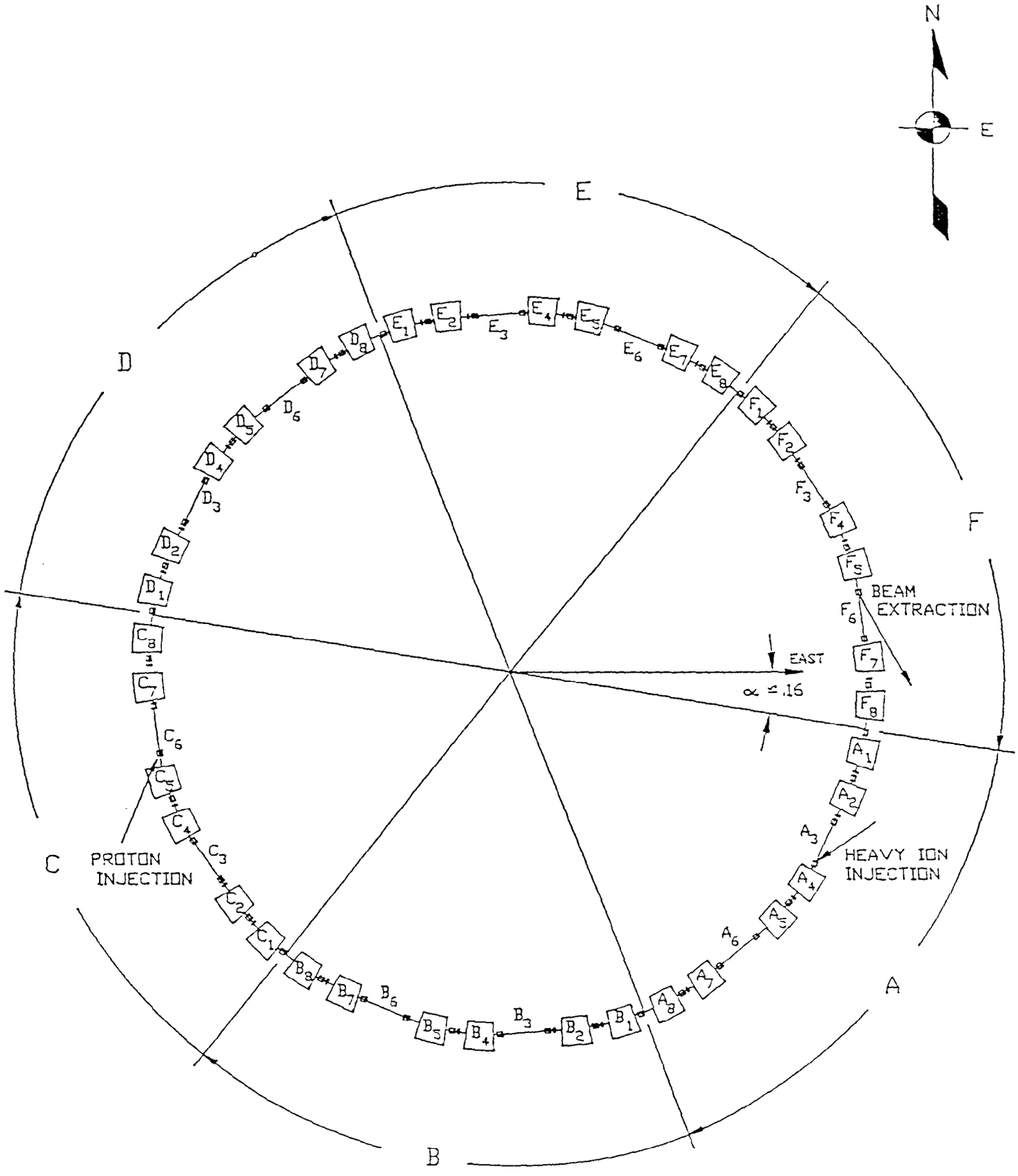


Fig.5 Layout of the AGS Booster showing the relative position of magnets (e.g. Dipole Apex locations) and labling convention of the Booster Superperiods. (A to F, with the Beam in the Clockwise direction).

5. Z. Parsa, AGS Booster Survey and Lattice Parameters with Program MAD; Booster Technical Note No. 99; November 1987.

6. Information received from F. Dell.

7. Program SYNCH is available in BNLDAG::DUA0:[PARSA1.SYNCH] DIRECTORY. A. Garren, Principal author, SSC Central Design Group, Berkeley California.

* We would like to thank E. Courant, F. Dell, P. Mohn and S. Tepikian for information and discussions.

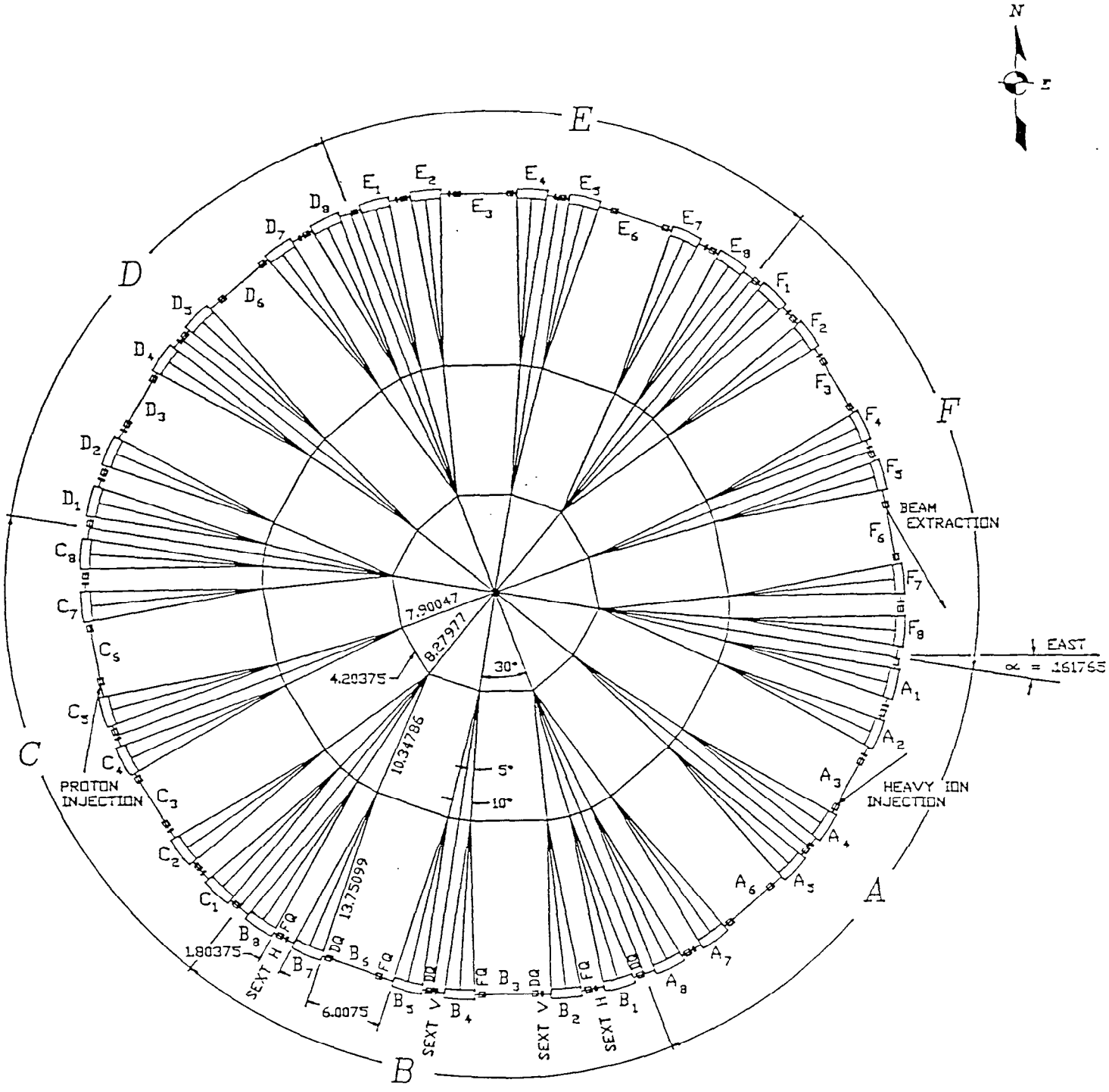


FIG. 6 Overall Layout of the AGS Booster

0 5
METERS
NOTE ALL DIMENSIONS ARE IN METERS

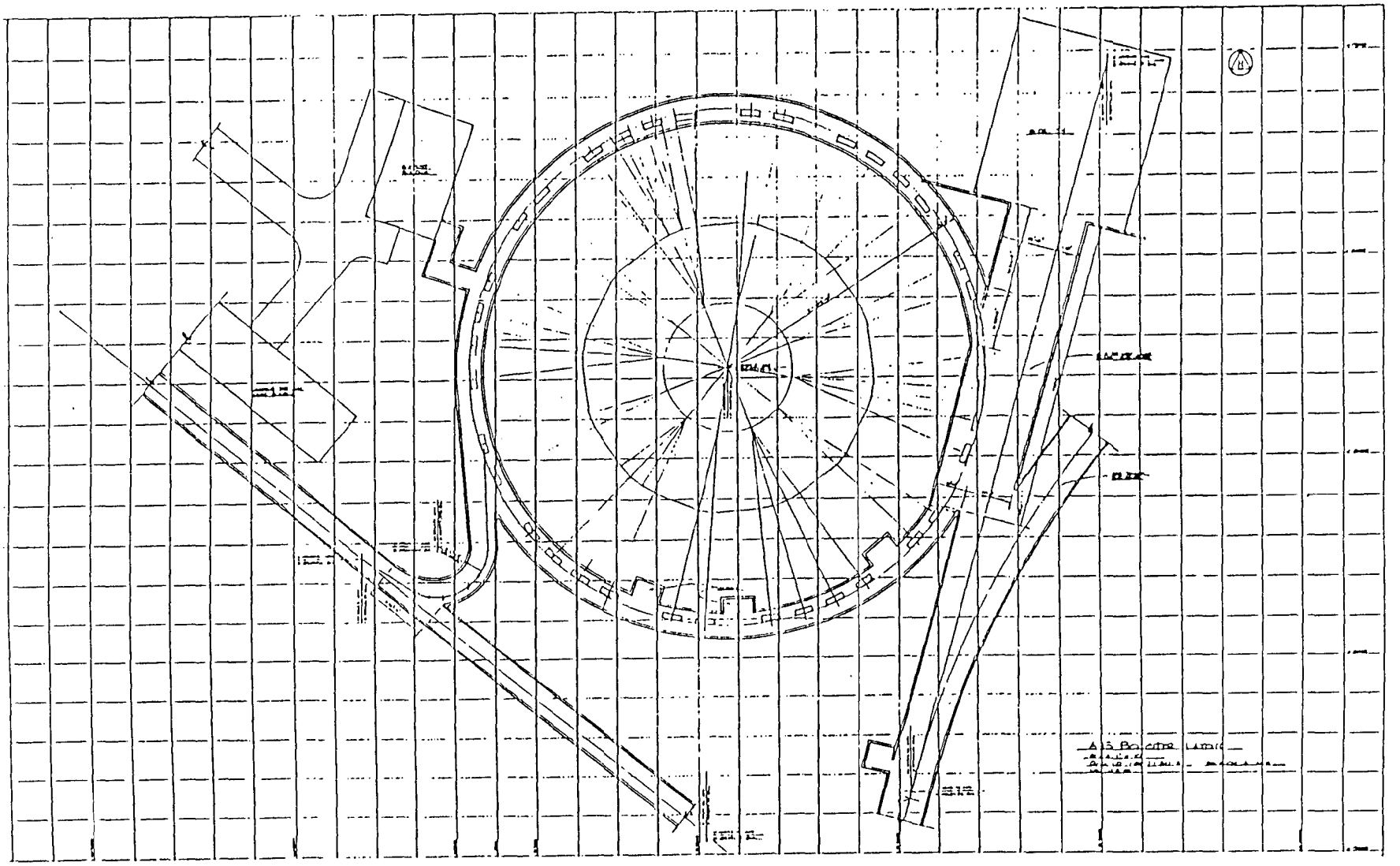


Fig. 7 Construction map of AGS Booster

TABLE I

NO.	MAGNETS	LENGTH	BEND ANGLE
1	QD	0.2519	0.000E+00
2	S30	0.3000	0.000E+00
3	BEND	2.4000	0.175E+00
4	S65	0.6500	0.000E+00
5	SXF	0.1000	0.000E+00
6	S25	0.2500	0.000E+00
7	QF	0.2519	0.000E+00
8	QF	0.2519	0.000E+00
9	S30	0.3000	0.000E+00
10	BEND	2.4000	0.175E+00
11	S65	0.6500	0.000E+00
12	SXD	0.1000	0.000E+00
13	S25	0.2500	0.000E+00
14	QD	0.2519	0.000E+00
15	QD	0.2519	0.000E+00
16	S370	3.7000	0.000E+00
17	QF	0.2519	0.000E+00
18	QF	0.2519	0.000E+00
19	S30	0.3000	0.000E+00
20	BEND	2.4000	0.175E+00
21	S65	0.6500	0.000E+00
22	SXD	0.1000	0.000E+00
23	S25	0.2500	0.000E+00
24	QD	0.2519	0.000E+00
25	QD	0.2519	0.000E+00
26	S30	0.3000	0.000E+00
27	BEND	2.4000	0.175E+00
28	S100	1.0000	0.000E+00
29	QF	0.2519	0.000E+00
30	QF	0.2519	0.000E+00
31	S370	3.7000	0.000E+00
32	QD	0.2519	0.000E+00
33	QD	0.2519	0.000E+00
34	S30	0.3000	0.000E+00
35	BEND	2.4000	0.175E+00
36	S65	0.6500	0.000E+00

TABLE I (Cont.)

NO.	MAGNETS	LENGTH	BEND ANGLE
37	SXF	0.1000	0.000E+00
38	S25	0.2500	0.000E+00
39	QF	0.2519	0.000E+00
40	QF	0.2519	0.000E+00
41	S30	0.3000	0.000E+00
42	BEND	2.4000	0.175E+00
43	S100	1.0000	0.000E+00
44	QD	0.2519	0.000E+00

TABLE II

	APEX	N(IN)	E(IN)	X(M)	Y(M)
1	A1	15172.5094	2392.1075	31.57798	-7.28601
2	A2	15016.0513	2337.4134	30.18875	-11.26004
3	A4	14727.0938	2175.4673	26.07532	-18.59956
4	A5	14598.7778	2070.5598	23.41067	-21.85879
5	A7	14382.6354	1819.5510	17.03504	-27.34880
6	A8	14297.9382	1677.0835	13.41637	-29.50011
7	B1	14239.2670	1522.0729	9.47910	-30.99036
8	B2	14208.4044	1359.2292	5.34287	-31.77427
9	B4	14204.1751	1028.0116	-3.07006	-31.88170
10	B5	14230.8696	864.4329	-7.22496	-31.20366
11	B7	14340.1785	551.7437	-15.16726	-28.42721
12	B8	14421.2103	407.1601	-18.83969	-26.36900
13	C1	14526.1178	278.8440	-22.09891	-23.70435
14	C2	14651.7134	170.6943	-24.84592	-20.51422
15	C4	14936.4415	1.4229	-29.14541	-13.28213
16	C5	15091.4521	-57.2483	-30.63566	-9.34486
17	C7	15416.9033	-118.9287	-32.20234	-1.07840
18	C8	15582.6323	-121.0449	-32.25609	3.13112
19	D1	15746.2111	-94.3504	-31.57805	7.28602
20	D2	15902.6692	-39.6562	-30.18882	11.26005
21	D4	16191.6266	122.2899	-26.07539	18.59957
22	D5	16319.9427	227.1973	-23.41074	21.85880
23	D7	16536.0851	478.2061	-17.03512	27.34882
24	D8	16620.7822	620.6736	-13.41644	29.50012
25	E1	16679.4535	775.6842	-9.47917	30.99037
26	E2	16710.3161	938.5280	-5.34294	31.77428
27	E4	16714.5453	1269.7455	3.06998	31.88171
28	E5	16687.8508	1433.3242	7.22488	31.20367
29	E7	16578.5420	1746.0134	15.16719	28.42722
30	E8	16497.5101	1890.5971	18.83961	26.36901
31	F1	16392.6027	2018.9131	22.09884	23.70436
32	F2	16267.0071	2127.0628	24.84584	20.51424
33	F4	15982.2789	2296.3342	29.14534	13.28214
34	F5	15827.2684	2355.0055	30.63559	9.34487
35	F7	15501.8172	2416.6858	32.20227	1.07841
36	F8	15336.0881	2418.8020	32.25602	-3.13111

No.	NAME	BOOSTER COORD X(M)	BOOSTER COORD Y(M)	AGS COORD E(IN)	AGS COORD N(IN)
1	MDA1	31.57798	-7.28601	2392.1075	15172.5094
2	MSFA1	30.93348	-9.12966	2366.7336	15099.9247
3	MQA1	30.76787	-9.60342	2360.2133	15081.2727
4	MDA2	30.18875	-11.26004	2337.4134	15016.0513
5	MSDA2	29.23390	-12.96377	2299.8208	14948.9754
6	MQA2	28.98853	-13.40157	2290.1606	14931.7390
7	MQA3	26.93331	-17.06867	2209.2464	14787.3652
8	MDA4	26.07532	-18.59956	2175.4673	14727.0938
9	MSDA4	24.83912	-20.11159	2126.7982	14667.5649
10	MQA4	24.52146	-20.50014	2114.2917	14652.2678
11	MDA5	23.41067	-21.85879	2070.5598	14598.7778
12	MQA5	21.55038	-23.46067	1997.3202	14535.7116
13	MQA6	18.36489	-26.20368	1871.9070	14427.7189
14	MDA7	17.03504	-27.34880	1819.5510	14382.6354
15	MSFA7	15.35625	-28.34685	1753.4569	14343.3424
16	MQA7	14.92486	-28.60331	1736.4728	14333.2453
17	MDA8	13.41637	-29.50011	1677.0835	14297.9382
18	MQA8	11.12040	-30.36913	1586.6909	14263.7248
19	MDB1	9.47910	-30.99036	1522.0729	14239.2670
20	MSFB1	7.56020	-31.35404	1446.5258	14224.9491
21	MQB1	7.06711	-31.44749	1427.1125	14221.2698
22	MDB2	5.34287	-31.77427	1359.2292	14208.4044
23	MSDB2	3.38997	-31.79921	1282.3435	14207.4227
24	MQB2	2.88814	-31.80562	1262.5862	14207.1704
25	MQB3	-1.31527	-31.85929	1097.0977	14205.0573
26	MDB4	-3.07006	-31.88170	1028.0116	14204.1751
27	MSDB4	-4.99761	-31.56714	952.1235	14216.5593
28	MQB4	-5.49294	-31.48630	932.6226	14219.7417
29	MDB5	-7.22496	-31.20366	864.4329	14230.8696
30	MQB5	-9.54237	-30.39354	773.1962	14262.7639
31	MQB6	-13.51064	-29.00633	616.9652	14317.3786
32	MDB7	-15.16726	-28.42721	551.7437	14340.1785
33	MSFB7	-16.87099	-27.47236	484.6679	14377.7711
34	MQB7	-17.30879	-27.22699	467.4315	14387.4312
35	MDB8	-18.83969	-26.36900	407.1601	14421.2103
36	MQB8	-20.74027	-24.81514	332.3341	14482.3859

No.	NAME	BOOSTER COORD X(M)	BOOSTER COORD Y(M)	AGS COORD E(IN)	AGS COORD N(IN)
37	MDC1	-22.09891	-23.70435	278.8440	14526.1178
38	MSFC1	-23.37331	-22.22437	228.6708	14584.3846
39	MQC1	-23.70080	-21.84407	215.7778	14599.3574
40	MDC2	-24.84592	-20.51422	170.6943	14651.7134
41	MSDC2	-25.84396	-18.83543	131.4013	14717.8075
42	MQC2	-26.10043	-18.40404	121.3042	14734.7916
43	MQC3	-28.24861	-14.79062	36.7299	14877.0523
44	MDC4	-29.14541	-13.28213	1.4229	14936.4415
45	MSDC4	-29.83677	-11.45554	-25.7961	15008.3547
46	MQC4	-30.01443	-10.98616	-32.7905	15026.8341
47	MDC5	-30.63566	-9.34486	-57.2483	15091.4521
48	MQC5	-31.09279	-6.93287	-75.2455	15186.4125
49	MQC6	-31.87556	-2.80264	-106.0632	15349.0199
50	MDC7	-32.20234	-1.07840	-118.9287	15416.9033
51	MSFC7	-32.22728	0.87450	-119.9104	15493.7890
52	MQC7	-32.23368	1.37633	-120.1627	15513.5462
53	MDC8	-32.25609	3.13112	-121.0449	15582.6323
54	MQC8	-31.86070	5.55400	-105.4783	15678.0213
55	MDD1	-31.57805	7.28602	-94.3504	15746.2111
56	MSFD1	-30.93355	9.12967	-68.9764	15818.7957
57	MQD1	-30.76794	9.60343	-62.4561	15837.4478
58	MDD2	-30.18882	11.26005	-39.6562	15902.6692
59	MSDD2	-29.23397	12.96378	-2.0636	15969.7450
60	MQD2	-28.98860	13.40158	7.5965	15986.9814
61	MQD3	-26.93338	17.06868	88.5108	16131.3552
62	MDD4	-26.07539	18.59957	122.2899	16191.6266
63	MSDD4	-24.83919	20.11161	170.9590	16251.1555
64	MQD4	-24.52153	20.50015	183.4654	16266.4526
65	MDD5	-23.41074	21.85880	227.1973	16319.9427
66	MQD5	-21.55045	23.46068	300.4369	16383.0089
67	MQD6	-18.36496	26.20370	425.8502	16491.0016
68	MDD7	-17.03512	27.34882	478.2061	16536.0851
69	MSFD7	-15.35633	28.34686	544.3002	16575.3781
70	MQD7	-14.92493	28.60333	561.2844	16585.4752
71	MDD8	-13.41644	29.50012	620.6736	16620.7822
72	MQD8	-11.12047	30.36915	711.0662	16654.9957

No.	NAME	BOOSTER COORD X(M)	BOOSTER COORD Y(M)	AGS COORD E(IN)	AGS COORD N(IN)
73	MDE1	-9.47917	30.99037	775.6842	16679.4535
74	MSFE1	-7.56028	31.35405	851.2314	16693.7714
75	MQE1	-7.06718	31.44750	870.6446	16697.4506
76	MDE2	-5.34294	31.77428	938.5280	16710.3161
77	MSDE2	-3.39004	31.79922	1015.4137	16711.2978
78	MQE2	-2.88821	31.80563	1035.1709	16711.5501
79	MQE3	1.31520	31.85930	1200.6594	16713.6632
80	MDE4	3.06998	31.88171	1269.7455	16714.5453
81	MSDE4	4.99754	31.56715	1345.6336	16702.1611
82	MQE4	5.49286	31.48632	1365.1345	16698.9788
83	MDE5	7.22488	31.20367	1433.3242	16687.8508
84	MQE5	9.54230	30.39355	1524.5610	16655.9566
85	MQE6	13.51056	29.00634	1680.7920	16601.3419
86	MDE7	15.16719	28.42722	1746.0134	16578.5420
87	MSFE7	16.87091	27.47237	1813.0892	16540.9494
88	MQE7	17.30872	27.22700	1830.3257	16531.2892
89	MDE8	18.83961	26.36901	1890.5971	16497.5101
90	MQE8	20.74019	24.81515	1965.4231	16436.3346
91	MDF1	22.09884	23.70436	2018.9131	16392.6027
92	MSFF1	23.37324	22.22439	2069.0864	16334.3359
93	MQF1	23.70072	21.84408	2081.9793	16319.3631
94	MDF2	24.84584	20.51424	2127.0628	16267.0071
95	MSDF2	25.84389	18.83545	2166.3559	16200.9130
96	MQF2	26.10035	18.40405	2176.4530	16183.9289
97	MQF3	28.24854	14.79063	2261.0272	16041.6682
98	MDF4	29.14534	13.28214	2296.3342	15982.2789
99	MSDF4	29.83670	11.45555	2323.5532	15910.3658
100	MQF4	30.01436	10.98617	2330.5477	15891.8864
101	MDF5	30.63559	9.34487	2355.0055	15827.2684
102	MQF5	31.09271	6.93288	2373.0026	15732.3079
103	MQF6	31.87549	2.80265	2403.8204	15569.7005
104	MDF7	32.20227	1.07841	2416.6858	15501.8172
105	MSFF7	32.22720	-0.87448	2417.6676	15424.9315
106	MQF7	32.23361	-1.37632	2417.9199	15405.1742
107	MDF8	32.25602	-3.13111	2418.8020	15336.0881
108	MQF8	31.86063	-5.55399	2403.2354	15240.6991