BROOKHAVEN NATIONAL LABORATORY
Associated Universities, Inc.
Upton, L.I., N.Y.

EDC-53
BNL-7643

ACCELERATOR DEPARTMENT
(AGS)

Internal Report

WHERE IS ZERO?

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Considerable confusion has arisen lately concerning the reference orbits with respect to which the radial locations of AGS beams and targets are measured. There are a number of different ways of defining the radial position. Among them are:

(1) The coordinate system used in the "BEAM" computer program described in EDC-36. In this system, the radial coordinate (called Y) in a straight section is measured from the line joining the aperture centerline (defined as a line 5.250 inches from the open face of the magnets) at the ends of the iron of the two adjacent magnets.

(2) The radial displacement from the line joining the surveying sockets on the tops of the two adjacent magnets. These sockets are located 3.000 inches from the magnet ends. Since the angle between two adjacent short magnets is 0.0235 radians, this line — in straight sections number 1,9,10,11,19,20 — is 0.03525 inches inside the "zero" line defined in (1).

(3) The target position indicators read zero when the reading is 0.1 inches inside of zero as defined in (2), or 0.13525 inches inside of zero as defined in (1).

(4) The radial displacement from a standard orbit. This standard orbit may be taken to be that equilibrium orbit whose circumference is 2π times the nominal radius of the AGS, 5057.4 inches. This definition is useful if the radius is measured by measuring the frequency of the circulating beam.

(5) The standard orbit may be taken to be the orbit whose mean position at all straight section centers (in terms of coordinate system (1)) is zero.

The attached tables show these radii, as well as some other properties of the orbits, for the three field levels used in the "BEAM" program, for nine orbits at each field level. In each set, Orbit 5 is the orbit whose mean radius as defined in (3) is zero; orbits 1 to 9 are orbits for particles with momenta from 2% less than that of orbit 5 to 2% more, in steps of 0.5%.

The first table of each set gives the "radial positions" of each of these orbits. They are essentially self-explanatory: RBAR = radius as defined by (4); RMASCH = radius as defined by (5);R10 radius in straight section number 10 as defined by (1); RSOCK the same as defined by (2); SLOPE = the slope of the orbit in milliradians from the reference line defined by (1). The radii R10 and RSOCK apply at the center of straight section 10; elsewhere one has to add a correction equal to (x-62) x SLOPE, where x is the distance of the target from the upstream end of the straight section (usually about 15 inches).

The second table of each set shows the radial position of each orbit, as defined by (1), at the centers of each of the twenty straight sections of a super-period.

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3 Figs.

RADII ØF EQUILIBRIUM ØRBITS
RBAR = MEAN DEVIATIØN FRØM CIRCLE ØF RADILS 5057.4 INCHES
RMASCH = MEAN RADIUS AT STRAIGHT SECTIØN CENTERS
R1O = DEVIATIØN FRØM APERTURE CENTER LINE AT 1O
RSØCK = DEVIATIØN FRØM SØCKET LINE AT 1O
SLØPE = SLØPE AT 1O IN MILLIRADIANS

INJECTION FIELD (1)

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ØRBIT NØ.	MØMENTUM	RBAR	RMASCH	R1O	RSØCK	SLØPE	NU-X	NU-Z
1	0.3962E 06	-1.38583	-1.38551	-1.34011	-1.30486	1.868	8.73426	9.00262
2	0.3982E 06	-1.04294	-1.03685	-0.98901	-0.95376	1.281	8.71105	8.92944
3	0.4002E 06	-0.69772	-0.68774	-0.63931	-0.60406	0.717	8.68910	8.85750
4	0.4023E 06	-0.35023	-0.33844	-0.29120	-0.25595	0.177	8.66830	8.78677
5	0.4043E 06	-0.00047	0.01085	0.05513	0.09038	-0.340	8.64854	8.71723
6	0.4063E 06	0.35052	0.35992	0.39953	0.43478	-0.833	8.62974	8.64883
7	0.4083E 06	0.70308	0.70856	0.74181	0.77706	-1.302	8.61177	8.58155
8	0.4104E 06	1.05699	1.05655	1.08182	1.11707	-1.749	8.59456	8.51535
9	0.4124E 06	1.41170	1.40373	1.41944	1.45469	-2.172	8.57801	8.45022

ØRBITS AT ALL STRAIGHT SECTIØNS

SS NØ.	ØRBIT 1	ØRBIT 2	ØRBIT 3	ØRBIT 4	ØRBIT 5	ØRBIT 6	ØRBIT 7	ØRBIT 8	ØRBIT 9
1	-1.471556	-1.077368	-0.687039	-0.300769	0.081264	0.458890	0.831953	1.200295	1.563796
2	-1.251008	-0.930541	-0.613065	-0.298777	0.012144	0.319529	0.623218	0.923053	1.218908
3	-1.031346	-0.783748	-0.538205	-0.294918	-0.054079	0.184137	0.419559	0.652020	0.881380
4	-1.153392	-0.866563	-0.583079	-0.303181	-0.027097	0.244971	0.512822	0.776268	1.035153
5	-1.314205	-0.977637	-0.645672	-0.318579	0.003393	0.320021	0.631089	0.936394	1.235772
6	-1.153393	-0.866565	-0.583081	-0.303183	-0.027099	0.244969	0.512820	0.776267	1.035153
7	-1.031350	-0.783754	-0.538210	-0.294922	-0.054083	0.184134	0.419554	0.652017	0.881381
8	-1.251017	-0.930553	-0.613076	-0.298785	0.012135	0.319522	0.623209	0.923048	1.218910
9	-1.471557	-1.077372	-0.687042	-0.300767	0.081265	0.458894	0.831953	1.200301	1.563811
10	-1.340111	-0.989011	-0.639310	-0.291200	0.055133	0.399526	0.741806	1.081824	1.419437
11	-1.217783	-0.909848	-0.600035	-0.288547	0.024427	0.338690	0.654053	0.970336	1.287355
12	-1.545323	-1.159122	-0.769101	-0.375518	0.021383	0.421345	0.824119	1.229461	1.637122
13	-1.869218	-1.404952	-0.935004	-0.459683	0.020721	0.505900	0.995550	1.489372	1.987061
14	-1.628158	-1.232092	-0.829968	-0.422050	-0.008589	0.410148	0.833896	1.262389	1.695360
15	-1.380128	-1.052685	-0.719507	-0.380814	-0.036816	0.312262	0.666199	1.024765	1.387738
16	-1.628173	-1.232105	-0.829982	-0.422064	-0.008603	0.410134	0.833884	1.262375	1.695345
17	-1.869245	-1.404975	-0.935029	-0.459708	0.020695	0.505873	0.995527	1.489345	1.987033
18	-1.545352	-1.159148	-0.769128	-0.375545	0.021354	0.421316	0.824093	1.229430	1.637091
19	-1.217796	-0.909859	-0.600047	-0.288560	0.024411	0.338673	0.654040	0.970318	1.287335
20	-1.340117	-0.989014	-0.639314	-0.291208	0.055126	0.399515	0.741799	1.081810	1.419415

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RADII ØF EQUILIBRIUM ØRBITS
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RIØ = DEVIATIØN FRØM APERTURE CENTER LINE AT IØ
RSØCK = DEVIATIØN FRØM SØCKET LINE AT IØ
SLØPE = SLØPE AT IØ IN MILLIRADIANS

ØRBIT NØ.	MØMENTUM	RBAR	RMASCH	RIØ	RSØCK	SLØPE	NU-X	NU-Z
1	0.1642E 08	-1.3744C	-1.37461	-1.36172	-1.32647	2.666	9.01878	8.75814
2	0.1650E 08	-1.04445	-1.03924	-1.01977	-0.98452	1.915	8.92062	8.75667
3	0.1658E 08	-0.70571	-0.69668	-0.67072	-0.63547	1.158	8.82218	8.75682
4	0.1667E 08	-0.35757	-0.34663	-0.31431	-0.27906	0.393	8.72343	8.75863
5	0.1675E 08	-0.00006	0.01119	0.04980	0.08505	-0.378	8.62432	8.76210
6	0.1683E 08	0.36742	0.37710	0.42186	0.45711	-1.156	8.52480	8.76726
7	0.1692E 08	0.74546	0.75144	0.80222	0.83747	-1.941	8.42482	8.77413
8	0.17C0E 08	1.13427	1.13457	1.19126	1.22651	-2.734	8.32434	8.78275
9	0.17C9E 08	1.53387	1.52690	1.58935	1.62460	-3.536	8.22329	8.79313

ØRBITS AT ALL STRAIGHT SECTIØNS

SS NØ.	ØRBIT 1	ØRBIT 2	ØRBIT 3	ØRBIT 4	ØRBIT 5	ØRBIT 6	ØRBIT 7	ØRBIT 8	ØRBIT 9
1	-1.597981	-1.189475	-0.773321	-0.349225	0.083093	0.523973	0.973755	1.432803	1.901526
2	-1.404003	-1.058488	-0.705928	-0.346078	0.021293	0.396462	0.779713	1.171344	1.571693
3	-1.221176	-0.934995	-0.642347	-0.343039	-0.036885	0.276330	0.596833	0.924860	1.260677
4	-1.443178	-1.094155	-0.738038	-0.374619	-0.003689	0.374977	0.761627	1.156522	1.559948
5	-1.671328	-1.257931	-0.836828	-0.407785	0.029436	0.475086	0.929444	1.392807	1.865498
6	-1.443181	-1.094157	-0.738040	-0.374624	-0.003691	0.374975	0.761623	1.156519	1.559947
7	-1.221184	-0.935001	-0.642353	-0.343051	-0.036889	0.276326	0.596826	0.924856	1.260675
8	-1.404019	-1.058501	-0.705939	-0.346100	0.021285	0.396454	0.779700	1.171337	1.571689
9	-1.597991	-1.189480	-0.773324	-0.349241	0.083095	0.523976	0.973752	1.432808	1.901535
10	-1.361723	-1.019774	-0.670724	-0.314306	0.049795	0.421860	0.802225	1.191262	1.589348
11	-1.113300	-0.841573	-0.563243	-0.278060	0.014264	0.314031	0.621561	0.937207	1.261341
12	-1.327771	-1.004758	-0.674400	-0.336385	0.009644	0.364067	0.727282	1.099728	1.481872
13	-1.548386	-1.171875	-0.787284	-0.394235	0.007694	0.418961	0.840043	1.271462	1.713779
14	-1.329339	-1.014122	-0.691479	-0.361070	-0.022522	0.324574	0.680644	1.046151	1.421600
15	-1.127039	-0.868441	-0.603098	-0.330714	-0.050972	0.236485	0.532026	0.836049	1.148992
16	-1.329351	-1.014134	-0.691493	-0.361080	-0.022534	0.324562	0.680634	1.046139	1.421588
17	-1.548409	-1.171897	-0.787309	-0.394253	0.007673	0.418940	0.840024	1.271439	1.713757
18	-1.327797	-1.004782	-0.674429	-0.336406	0.009619	0.364042	0.727260	1.099701	1.481845
19	-1.113310	-0.841582	-0.563256	-0.278067	0.014253	0.314019	0.621551	0.937192	1.261325
20	-1.361720	-1.019775	-0.670728	-0.314297	0.049787	0.421850	0.802221	1.191251	1.589332

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ØRBIT NØ.	MØMENTUM	RBAR	RMASCH	R10	RSØCK	SLØPE	NU-X	NU-Z
1	0.4332E 08	-1.37708	-1.37674	-1.36613	-1.33088	2.605	9.37885	7.62849
2	0.4354E 08	-1.06730	-1.06208	-1.04500	-1.00975	1.912	9.11850	7.85587
3	0.4377E 08	-0.73753	-0.72883	-0.70559	-0.67034	1.197	8.83944	8.08042
4	0.4399E 08	-0.38392	-0.37328	-0.34417	-0.30892	0.453	8.53306	8.30738
5	0.4421E 08	-0.00087	0.01009	0.04482	0.08007	-0.330	8.18580	8.54371
6	0.4443E 08	0.42110	0.43017	0.47037	0.50562	-1.168	7.77472	8.79965
7	0.4465E 08	0.89839	0.90282	0.94861	0.98386	-2.093	7.25609	9.09240
8	0.4487E 08	1.46684	1.46208	1.51428	1.54953	-3.170	6.52486	9.45700
9	0.4509E 08	2.23812	2.21568	2.27762	2.31287	-4.612	6.74826	10.00100

ØRBITS AT ALL STRAIGHT SECTIØNS

SS NØ.	ØRBIT 1	ØRBIT 2	ØRBIT 3	ØRBIT 4	ØRBIT 5	ØRBIT 6	ØRBIT 7	ØRBIT 8	ØRBIT 9
1	-1.597487	-1.214515	-0.811603	-0.384481	0.073331	0.572336	1.131471	1.791434	2.681266
2	-1.410240	-1.084027	-0.740721	-0.376582	0.014057	0.440374	0.918880	1.485007	2.250854
3	-1.234276	-0.961334	-0.674054	-0.369196	-0.041870	0.315837	0.718124	1.195397	1.843551
4	-1.453695	-1.121989	-0.774145	-0.406360	-0.012875	0.415662	0.896042	1.464274	2.233895
5	-1.677701	-1.286484	-0.877023	-0.444945	0.016372	0.517712	1.078464	1.740256	2.634446
6	-1.453709	-1.121993	-0.774149	-0.406363	-0.012877	0.415661	0.896040	1.464278	2.233961
7	-1.234308	-0.961344	-0.674062	-0.369202	-0.041876	0.315836	0.718120	1.195407	1.843697
8	-1.410301	-1.084045	-0.740736	-0.376594	0.014046	0.440372	0.918871	1.485025	2.251130
9	-1.597557	-1.214528	-0.811610	-0.384484	0.073329	0.572346	1.131473	1.791473	2.681656
10	-1.366130	-1.044998	-0.705590	-0.344172	0.044818	0.470370	0.948611	1.514277	2.277620
11	-1.121351	-0.865706	-0.593262	-0.300881	0.016079	0.365005	0.759125	1.226689	1.857276
12	-1.324926	-1.024295	-0.703367	-0.358491	0.015701	0.427693	0.892630	1.442797	2.180632
13	-1.533973	-1.186449	-0.815145	-0.415882	0.017461	0.494518	1.032445	1.667783	2.516527
14	-1.322428	-1.030549	-0.717661	-0.380151	-0.012735	0.392903	0.851559	1.394731	2.122394
15	-1.128267	-0.887375	-0.628371	-0.348186	-0.042323	0.296303	0.680294	1.136481	1.749982
16	-1.322393	-1.030551	-0.717672	-0.380163	-0.012746	0.392893	0.851549	1.394736	2.122476
17	-1.533908	-1.186452	-0.815166	-0.415903	0.017440	0.494499	1.032426	1.667791	2.516679
18	-1.324854	-1.024299	-0.703390	-0.358515	0.015677	0.427671	0.892608	1.442806	2.180810
19	-1.121261	-0.865694	-0.593270	-0.300891	0.016068	0.364995	0.759114	1.226711	1.857482
20	-1.366071	-1.044993	-0.705589	-0.344176	0.044813	0.470354	0.948602	1.514230	2.277216