January 17, 1979

UPC 046

Uniform Use of 4 Inch Bore Magnets in Doubler

S. C. Snowdon

The term 4" bore magnets is a shorthand description for larger aperture magnets in the doubler. For dipoles the inner conductor diameter is 4 inches and for quadrupoles the inner conductor radius is 4.5 inches. The corresponding magnet size is approximately 14 inches by 20 inches for both dipoles and quadrupoles.

Arguments for the Use of 4 Inch Magnets

Although not all the advantages can be obtained simultaneously individually they are:

1. Comfortable design field
   a. Relaxed construction tolerances to achieve a "good field width" of ±.90 inch at maximum β.
   b. Theoretical "good field width" of ±1.375 inch at maximum β.
2. Permits use of straight magnets
   a. Simpler quality control
3. Must learn how to build high quality 4 inch magnets even if 3 inch magnets are used.
   a. High-β lattice needed as per Tom Collins
4. Probably will not need to reposition magnets
5. Comfortable stacked beams
   a. $\Delta p/p = \pm .0059$ for tune variation of ±.03
6. More flexibility in future lattice modifications
7. Better diagnostic capability
   a. Lattice optics based on linear elements

8. Only one cross section for all dipoles
   a. Similarly only one cross section for all quadrupoles
9. Beam intensity thresholds for resistive wall instabilities increased considerably.
   a. Longitudinal coupling impedance reduced by 30 percent
   b. Beam-induced higher mode losses reduced by 30 percent
10. Could use aluminum collars
   a. Pre-load increased by cooldown
   b. Eddy current loss less than .05 W/magnet
11. Smaller correction elements
12. Smaller heat load on cryogenic system by beam loss mechanisms
13. Need not achieve 100 percent of design quality in construction

Arguments Against the Use of 4 Inch Magnets

1. Larger magnet cross section
   a. Must redesign magnet stands
   b. Increase interference with MR during installation
2. Cost increase
   a. Probably 30 percent greater cost
3. Must retool
   a. Probably one year delay in obtaining magnets
4. Increased beam separation
   a. Beam plane of Doubler two inches further away from beam plane of MR
5. Increased stored energy
   a. May be a problem for magnetic energy dump
   b. May increase inventory of helium

INTEGRATED MULTIPOLE STRUCTURE OF G-SERIES DOUBLER DIPOLE ENDEM 011779-1430

ORDER OF POLE	= 1	CALCULATIONAL MODE	= 1	NUMBER OF LAYERS	= 4
HIGHEST MULTIPOLE ORDER	= 19	CONDUCTOR CURRENT(A)	= 4691.0000	REFERENCE RADIUS(IN)	= 1.0000
INNER IRON RADIUS(IN)	= 5.2500	HORIZONTAL INCREMENT(IN)	= .1000	ELLIPTICITY OF ENDS(IN)	= 0.0000

LAYER	TURNS	FBC (IN)	WIDTH (IN)	HGTMAX (IN)	HGTMIN (IN)	CURDEN (KA/IN/IN)	THETAS (DEG)	THETAF (DEG)	SPACER (IN)	RINNER (IN)	ROUTER (IN)	LENGTH (IN)	WRAP (IN)
1	15.0	0.000	.3070	.0550	.0460	302.577	.1327	24.2800	.0000733	2.0000	2.3170	248.4450	.0050
2	28.0	0.000	.3070	.0550	.0460	302.577	26.1243	73.5532	.0016565	2.0000	2.3170	248.4450	.0050
3	1.0	0.000	.3070	.0550	.0460	302.577	.1143	1.9623	.0100000	2.3380	2.6550	247.5000	.0050
4	28.0	0.000	.3070	.0550	.0460	302.577	1.9623	40.6128	-.0001770	2.3380	2.6550	247.5000	.0050

MULTIPOLE COEFFICIENTS OF FIELD AT REFERENCE RADIUS

N	NET FIELD HY(KG-IN)	NET FIELD HX(KG-IN)	AIR FIELD HY(KG-IN)	AIR FIELD HX(KG-IN)	IRON CONTR. HY(KG-IN)	IRON CONTR. HX(KG-IN)	NORMALIZED FIELD HY/HYO	NORMALIZED FIELD HX/HYO
1	11350.474791	0.000000	9512.846035	0.000000	1837.628726	0.000000	1.000000	0.000000
3	.132057	0.000000	-1.557216	0.000000	1.789263	0.000000	.000012	0.000000
5	-.604405	0.000000	-.597711	0.000000	-.006695	0.000000	-.000053	0.000000
7	1.474660	0.000000	1.474757	0.000000	-.000097	0.000000	.000130	0.000000
9	-1.022911	0.000000	-1.022911	0.000000	-.000000	0.000000	-.000090	0.000000
11	.284200	0.000000	.284230	0.000000	.000000	0.000000	.000025	0.000000
13	-.061505	0.000000	-.061505	0.000000	-.000000	0.000000	-.000005	0.000000
15	-.002308	0.000000	-.002308	0.000000	-.000000	0.000000	-.000000	0.000000
17	-.000197	0.000000	-.000197	0.000000	-.000000	0.000000	-.000000	0.000000
19	-.000132	0.000000	-.000132	0.000000	.000000	0.000000	-.000000	0.000000

MEDIAN PLANE FIELD VERSUS DISTANCE

X(IN)	NET FIELD HY(KG-IN)	NET FIELD HX(KG-IN)	AIR FIELD HY(KG-IN)	AIR FIELD HX(KG-IN)	IRON CONTR. HY(KG-IN)	IRON CONTR. HX(KG-IN)	NORMALIZED FIELD HY/HYO	NORMALIZED FIELD HX/HYO
.000	11350.475	0.000	9512.846	0.000	1837.629	0.000	1.000000	0.000000
.100	11350.476	0.000	9512.829	0.000	1837.647	0.000	1.000000	0.000000
.200	11350.479	0.000	9512.779	0.000	1837.700	0.000	1.000000	0.000000
.300	11350.483	0.000	9512.693	0.000	1837.790	0.000	1.000001	0.000000
.400	11350.486	0.000	9512.571	0.000	1837.915	0.000	1.000001	0.000000
.500	11350.489	0.000	9512.414	0.000	1838.076	0.000	1.000001	0.000000
.600	11350.497	0.000	9512.225	0.000	1838.272	0.000	1.000002	0.000000
.700	11350.516	0.000	9512.012	0.000	1838.504	0.000	1.000004	0.000000
.800	11350.553	0.000	9511.782	0.000	1838.771	0.000	1.000007	0.000000
.900	11350.610	0.000	9511.536	0.000	1839.074	0.000	1.000012	0.000000
1.000	11350.674	0.000	9511.253	0.000	1839.411	0.000	1.000018	0.000000
1.100	11350.703	0.000	9510.919	0.000	1839.784	0.000	1.000020	0.000000
1.200	11350.591	0.000	9510.410	0.000	1840.191	0.000	1.000010	0.000000
1.300	11350.112	0.000	9509.479	0.000	1840.633	0.000	.999968	0.000000
1.400	11348.797	0.000	9507.588	0.000	1841.109	0.000	.999852	0.000000
1.500	11345.703	0.000	9504.083	0.000	1841.620	0.000	.999580	0.000000
1.600	11338.944	0.000	9496.780	0.000	1842.164	0.000	.998984	0.000000
1.700	11324.803	0.000	9482.061	0.000	1842.741	0.000	.997738	0.000000
1.800	11296.065	0.000	9452.713	0.000	1843.352	0.000	.995206	0.000000
1.900	11238.946	0.000	9394.950	0.000	1843.996	0.000	.990174	0.000000
2.000	11127.552	0.000	9282.880	0.000	1844.672	0.000	.980360	0.000000

INTEGRATED MULTIPOLE STRUCTURE OF G-SERIES DOUBLER DIPOLE ENDEM

ORDER OF POLE	= 1	CALCULATIONAL MODE	= 0	NUMBER OF LAYERS	= 4
HIGHEST MULTIPOLE ORDER	= 19	CONDUCTOR CURRENT(A)	= 4691.0000	REFERENCE RADIUS(IN)	= 1.0000
INNER IRON RADIUS(IN)	= 5.2500	HORIZONTAL INCREMENT(IN)	= .1000	ELLIPTICITY OF ENDS(IN)	= 0.0000

LAYER	TURNS	FBC (IN)	WIDTH (IN)	HGTMAX (IN)	HGTMIN (IN)	JORDEN (KA/IN/IN)	THETAS (DEG)	THETAF (DEG)	SPACER (IN)	RINNER (IN)	ROUTER (IN)	LENGTH (IN)	WRAP (IN)
1	15.0	0.000	.3070	.0550	.0460	302.577	.1327	24.2800	.0000733	2.0000	2.3170	1.0000	.0050
2	28.0	0.000	.3070	.0550	.0460	302.577	26.1248	73.5532	.0016565	2.0000	2.3170	1.0000	.0050
3	1.0	0.000	.3070	.0550	.0460	302.577	.1148	1.9623	.0100000	2.3380	2.6550	1.0000	.0050
4	28.0	0.000	.3070	.0550	.0460	302.577	1.9623	40.6128	-.0001770	2.3380	2.6550	1.0000	.0050

MULTIPOLE COEFFICIENTS OF FIELD AT REFERENCE RADIUS

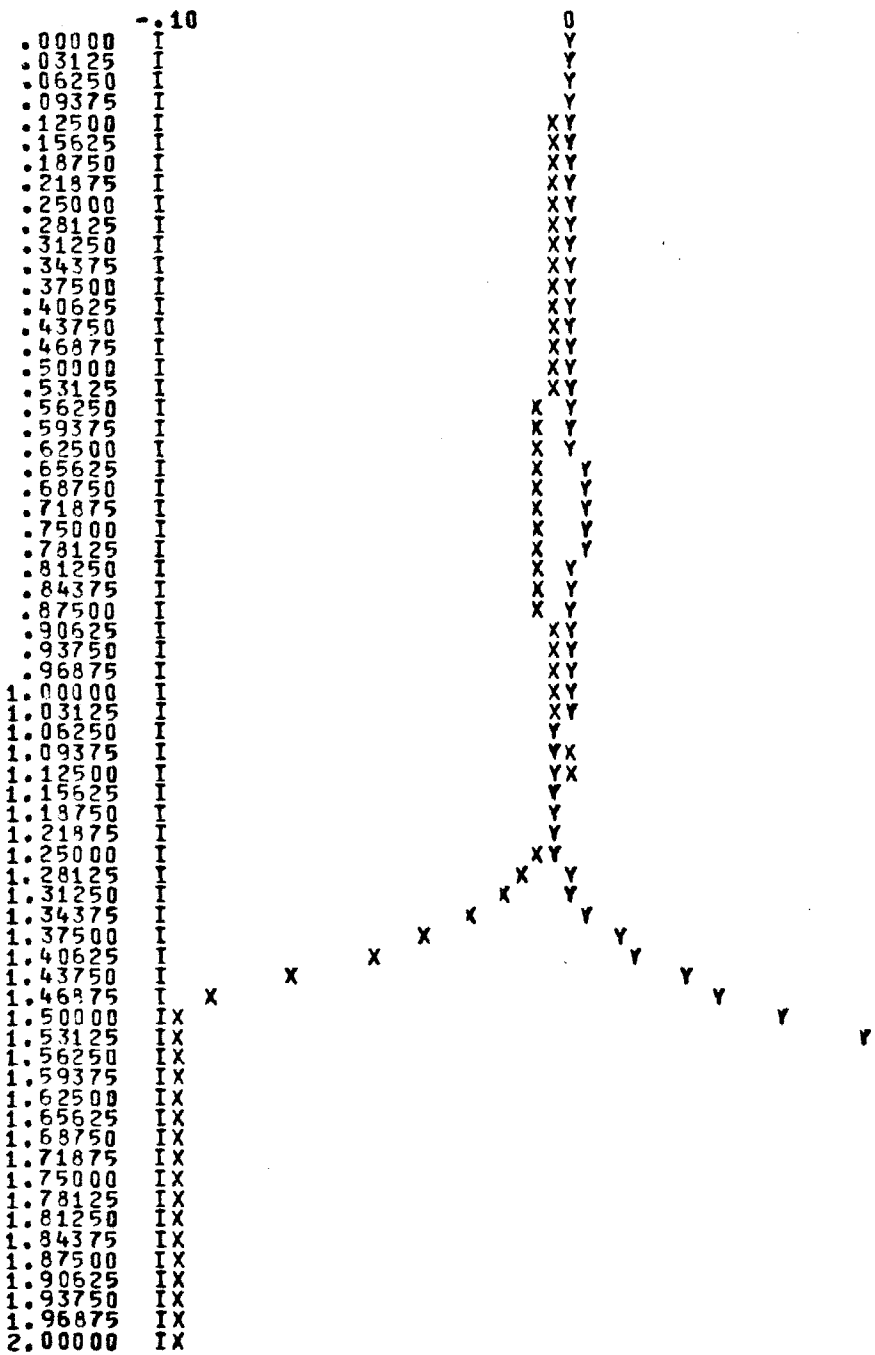
N	NET FIELD HY(KG-IN)	NET FIELD HX(KG-IN)	AIR FIELD HY(KG-IN)	AIR FIELD HX(KG-IN)	IRON CONTR. HY(KG-IN)	IRON CONTR. HX(KG-IN)	NORMALIZED FIELD HY/HYO	NORMALIZED FIELD HX/HYO
1	44.997710	0.000000	37.713382	0.000000	7.284328	0.000000	1.000000	0.000000
3	.033703	0.000000	.026232	0.000000	.007421	0.000000	.000749	0.000000
5	.000172	0.000000	.000198	0.000000	-.000025	0.000000	.000004	0.000000
7	.006261	0.000000	.006262	0.000000	-.000000	0.000000	.000139	0.000000
9	-.004081	0.000000	-.004081	0.000000	-.000000	0.000000	-.000091	0.000000
11	.001150	0.000000	.001150	0.000000	.000000	0.000000	.000026	0.000000
13	-.000245	0.000000	-.000245	0.000000	-.000000	0.000000	-.000005	0.000000
15	-.000009	0.000000	-.000009	0.000000	-.000000	0.000000	-.000000	0.000000
17	-.000001	0.000000	-.000001	0.000000	-.000000	0.000000	-.000000	0.000000
19	-.000001	0.000000	-.000001	0.000000	.000000	0.000000	-.000000	0.000000

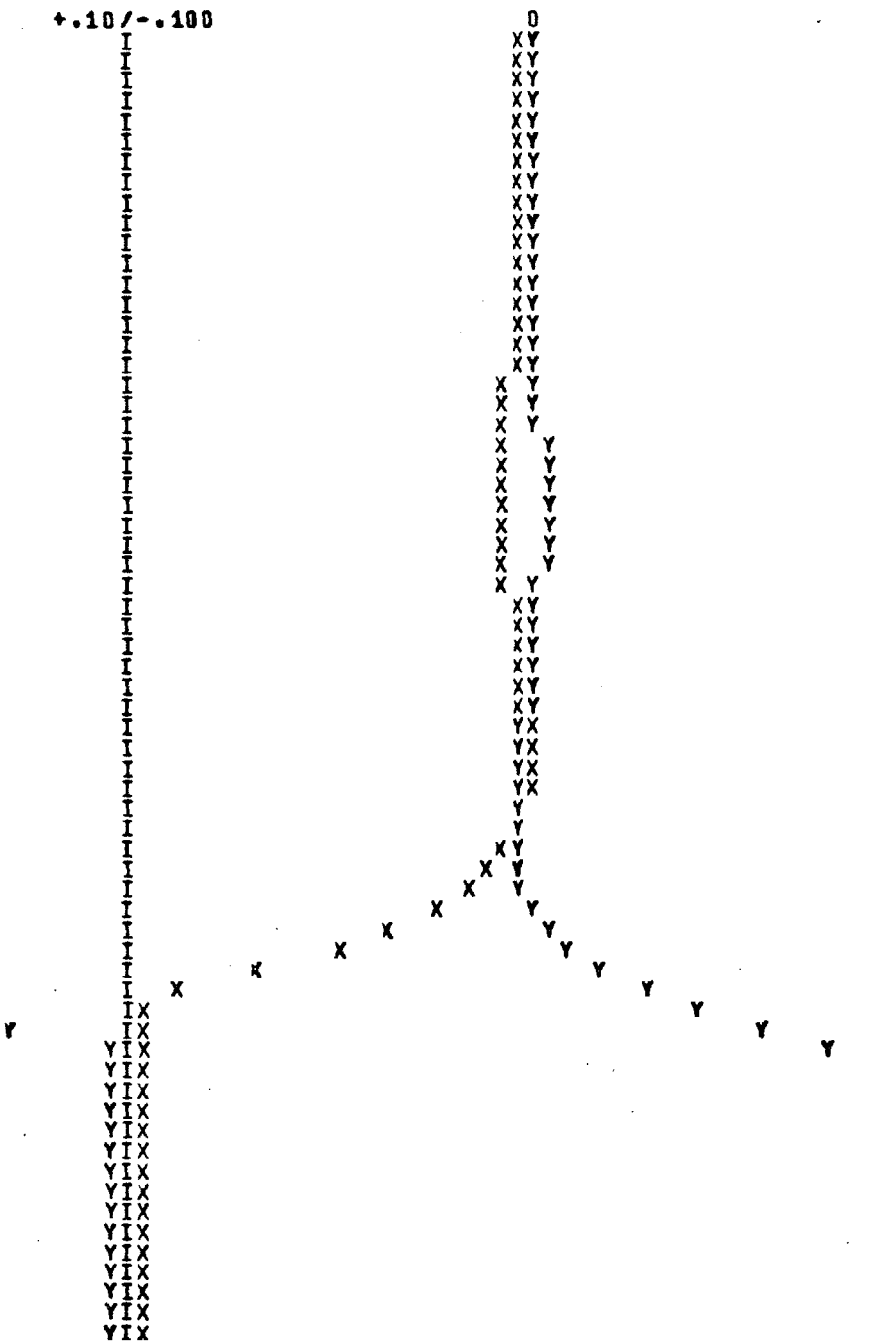
MEDIAN PLANE FIELD VERSUS DISTANCE

X(IN)	NET FIELD HY(KG-IN)	NET FIELD HX(KG-IN)	AIR FIELD HY(KG-IN)	AIR FIELD HX(KG-IN)	IRON CONTR. HY(KG-IN)	IRON CONTR. HX(KG-IN)	NORMALIZED FIELD HY/HYO	NORMALIZED FIELD HX/HYO
.000	44.998	0.000	37.713	0.000	7.284	0.000	1.000000	0.000000
.100	44.998	0.000	37.714	0.000	7.284	0.000	1.000007	0.000000
.200	44.999	0.000	37.714	0.000	7.285	0.000	1.000030	0.000000
.300	45.001	0.000	37.716	0.000	7.285	0.000	1.000068	0.000000
.400	45.003	0.000	37.718	0.000	7.286	0.000	1.000120	0.000000
.500	45.006	0.000	37.720	0.000	7.286	0.000	1.000189	0.000000
.600	45.010	0.000	37.723	0.000	7.287	0.000	1.000275	0.000000
.700	45.015	0.000	37.727	0.000	7.288	0.000	1.000380	0.000000
.800	45.020	0.000	37.731	0.000	7.289	0.000	1.000505	0.000000
.900	45.027	0.000	37.737	0.000	7.290	0.000	1.000651	0.000000
1.000	45.035	0.000	37.743	0.000	7.292	0.000	1.000821	0.000000
1.100	45.043	0.000	37.750	0.000	7.293	0.000	1.001012	0.000000
1.200	45.053	0.000	37.758	0.000	7.295	0.000	1.001218	0.000000
1.300	45.062	0.000	37.765	0.000	7.297	0.000	1.001423	0.000000
1.400	45.069	0.000	37.771	0.000	7.299	0.000	1.001591	0.000000
1.500	45.072	0.000	37.771	0.000	7.301	0.000	1.001644	0.000000
1.600	45.062	0.000	37.759	0.000	7.303	0.000	1.001425	0.000000
1.700	45.025	0.000	37.720	0.000	7.306	0.000	1.000617	0.000000
1.800	44.935	0.000	37.627	0.000	7.308	0.000	.998601	0.000000
1.900	44.736	0.000	37.425	0.000	7.311	0.000	.994181	0.000000
2.000	44.328	0.000	37.014	0.000	7.314	0.000	.985106	0.000000

MAX. FIELD ON IRON(KG) = 14.1353 IRON PERMEABILITY AT BMAXFE= 618.7508 FLUX IN IRON(KG-IN) = 77.1481

011779-1430





	DTX	DT
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.21875	.0001	.0
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.28125	.0001	.0
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.50000	.0001	-.0
.53125	.0001	-.0
.56250	.0000	-.0
.59375	.0000	-.0
.62500	-.0000	-.0
.65625	-.0001	-.0
.68750	-.0001	-.0
.71875	-.0001	-.0
.75000	-.0002	-.0
.78125	-.0002	-.0
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1.06250	-.0006	.0
1.09375	-.0006	.0
1.12500	-.0006	.0
1.15625	-.0006	.0
1.18750	-.0007	.0
1.21875	-.0007	.0
1.25000	-.0007	.0
1.28125	-.0007	.0
1.31250	-.0007	.0
1.34375	-.0007	.0
1.37500	-.0007	.0
1.40625	-.0007	.0
1.43750	-.0008	.0
1.46875	-.0008	.01
1.50000	-.0009	.01
1.53125	-.0010	.01
1.56250	-.0011	.02
1.59375	-.0013	.02
1.62500	-.0015	.03
1.65625	-.0019	.03
1.68750	-.0023	.04
1.71875	-.0028	.05
1.75000	-.0036	.06
1.78125	-.0045	.07
1.81250	-.0056	.09
1.84375	-.0070	.11
1.87500	-.0087	.13
1.90625	-.0109	.15
1.93750	-.0136	.18
1.96875	-.0169	.22
2.00000		

INTEGRATED MULTIPOLE STRUCTURE OF G-SERIES QUADRUPOLE(100577 KEYSTONED) ENDEM 011779-1500

ORDER OF POLE	= 2	CALCULATIONAL MODE	= 1	NUMBER OF LAYERS	= 4
HIGHEST MULTIPOLE ORDER	= 18	CONDUCTOR CURRENT(A)	= 4691.0000	REFERENCE RADIUS(IN)	= 1.0000
INNER IRON RADIUS(IN)	= 5.2500	HORIZONTAL INCREMENT(IN)	= .1000	ELLIPTICITY OF ENDS(IN)	= .0000

LAYER	TURNS	FBC (IN)	WIDTH (IN)	HGTMAX (IN)	HGTMIN (IN)	CURDEN (KA/IN/IN)	THETAS (DEG)	THETAF (DEG)	SPACER (IN)	RINNER (IN)	ROUTER (IN)	LENGTH (IN)	WRAP (IN)
1	25.0	0.000	.3070	.0550	.0460	302.577	.1189	37.0848	.0008281	2.2500	2.5670	63.0000	.0050
2	15.0	0.000	.3070	.0550	.0460	302.577	.1043	19.2076	.0002742	2.5880	2.9050	63.0000	.0050
3	1.0	0.000	.3070	.0550	.0460	302.577	.0929	1.4396	.0060000	2.9260	3.2430	63.0000	.0050
4	17.0	0.000	.3070	.0550	.0460	302.577	1.4395	20.6667	.0001937	2.9260	3.2430	63.0000	.0050

MULTIPOLE COEFFICIENTS OF FIELD AT REFERENCE RADIUS

N	NET FIELD HY(KG-IN)	NET FIELD HX(KG-IN)	AIR FIELD HY(KG-IN)	AIR FIELD HX(KG-IN)	IRON CONTR. HY(KG-IN)	IRON CONTR. HX(KG-IN)	NORMALIZED FIELD HY/XGYO	NORMALIZED FIELD HX/XGYO
2	1402.742095	0.000000	1308.338219	0.000000	94.403876	0.000000	1.000000	0.000000
6	.000157	0.000000	-.003170	0.000000	.003328	0.000000	.000000	0.000000
10	-.000187	0.000000	-.000187	0.000000	-.000000	0.000000	-.000000	0.000000
14	.000218	0.000000	.000218	0.000000	-.000000	0.000000	.000000	0.000000
18	-.000056	0.000000	-.000056	0.000000	.000000	0.000000	-.000000	0.000000

MEDIAN PLANE FIELD VERSUS DISTANCE

X(IN)	NET FIELD HY(KG-IN)	NET FIELD HX(KG-IN)	AIR FIELD HY(KG-IN)	AIR FIELD HX(KG-IN)	IRON CONTR. HY(KG-IN)	IRON CONTR. HX(KG-IN)	NORMALIZED FIELD HY/XGYO	NORMALIZED FIELD HX/XGYO
.000	.000	0.000	.000	0.000	.000	0.000	1.000000	0.000000
.100	140.274	0.000	131.834	0.000	9.440	0.000	1.000000	0.000000
.200	280.548	0.000	261.668	0.000	18.881	0.000	1.000000	0.000000
.300	420.823	0.000	392.501	0.000	28.321	0.000	1.000000	0.000000
.400	561.097	0.000	523.335	0.000	37.762	0.000	1.000000	0.000000
.500	701.371	0.000	654.169	0.000	47.202	0.000	1.000000	0.000000
.600	841.645	0.000	785.003	0.000	56.643	0.000	1.000000	0.000000
.700	981.920	0.000	915.836	0.000	66.083	0.000	1.000000	0.000000
.800	1122.194	0.000	1046.670	0.000	75.524	0.000	1.000000	0.000000
.900	1262.468	0.000	1177.503	0.000	84.965	0.000	1.000000	0.000000
1.000	1402.742	0.000	1308.335	0.000	94.407	0.000	1.000000	0.000000
1.100	1543.017	0.000	1439.167	0.000	103.850	0.000	1.000000	0.000000
1.200	1683.291	0.000	1569.998	0.000	113.293	0.000	1.000000	0.000000
1.300	1823.565	0.000	1700.828	0.000	122.737	0.000	1.000000	0.000000
1.400	1963.836	0.000	1831.653	0.000	132.183	0.000	.999999	0.000000
1.500	2104.094	0.000	1962.463	0.000	141.631	0.000	.999991	0.000000
1.600	2244.309	0.000	2093.227	0.000	151.081	0.000	.999965	0.000000
1.700	2384.393	0.000	2223.859	0.000	160.534	0.000	.999887	0.000000
1.800	2524.128	0.000	2354.138	0.000	169.990	0.000	.999680	0.000000
1.900	2662.992	0.000	2483.542	0.000	179.450	0.000	.999168	0.000000
2.000	2799.817	0.000	2610.913	0.000	188.914	0.000	.997980	0.000000
2.100	2932.111	0.000	2733.727	0.000	198.384	0.000	.995367	0.000000
2.200	3054.772	0.000	2846.912	0.000	207.860	0.000	.989870	0.000000

INTEGRATED MULTIPOLE STRUCTURE OF G-SERIES QUADRUPOLE(100577 KEYSTONED) ENDEM 011779 -1500

ORDER OF POLE	= 2	CALCULATIONAL MODE	= 0	NUMBER OF LAYERS	= 4
HIGHEST MULTIPOLE ORDER	= 18	CONDUCTOR CURRENT(A)	= 4691.0000	REFERENCE RADIUS(IN)	= 1.0000
INNER IRON RADIUS(IN)	= 5.2500	HORIZONTAL INCREMENT(IN)	= .1000	ELLIPTICITY OF ENDS(IN)	= .0000

LAYER	TURNS	FBC (IN)	WIDTH (IN)	HGTMAX (IN)	HGTMIN (IN)	CURDEN (KA/IN/IN)	THETAS (DEG)	THETAF (DEG)	SPACER (IN)	RINNER (IN)	ROUTER (IN)	LENGTH (IN)	WRAP (IN)
1	25.0	0.000	.3070	.0550	.0460	302.577	.1183	37.0848	.0008281	2.2500	2.5670	1.0000	.0050
2	15.0	0.000	.3070	.0550	.0460	302.577	.1043	19.2076	.0002742	2.5880	2.9050	1.0000	.0050
3	1.0	0.000	.3070	.0550	.0460	302.577	.0923	1.4396	.0050000	2.9260	3.2430	1.0000	.0050
4	17.0	0.000	.3070	.0550	.0460	302.577	1.4395	20.6667	.0001937	2.9260	3.2430	1.0000	.0050

MULTIPOLE COEFFICIENTS OF FIELD AT REFERENCE RADIUS

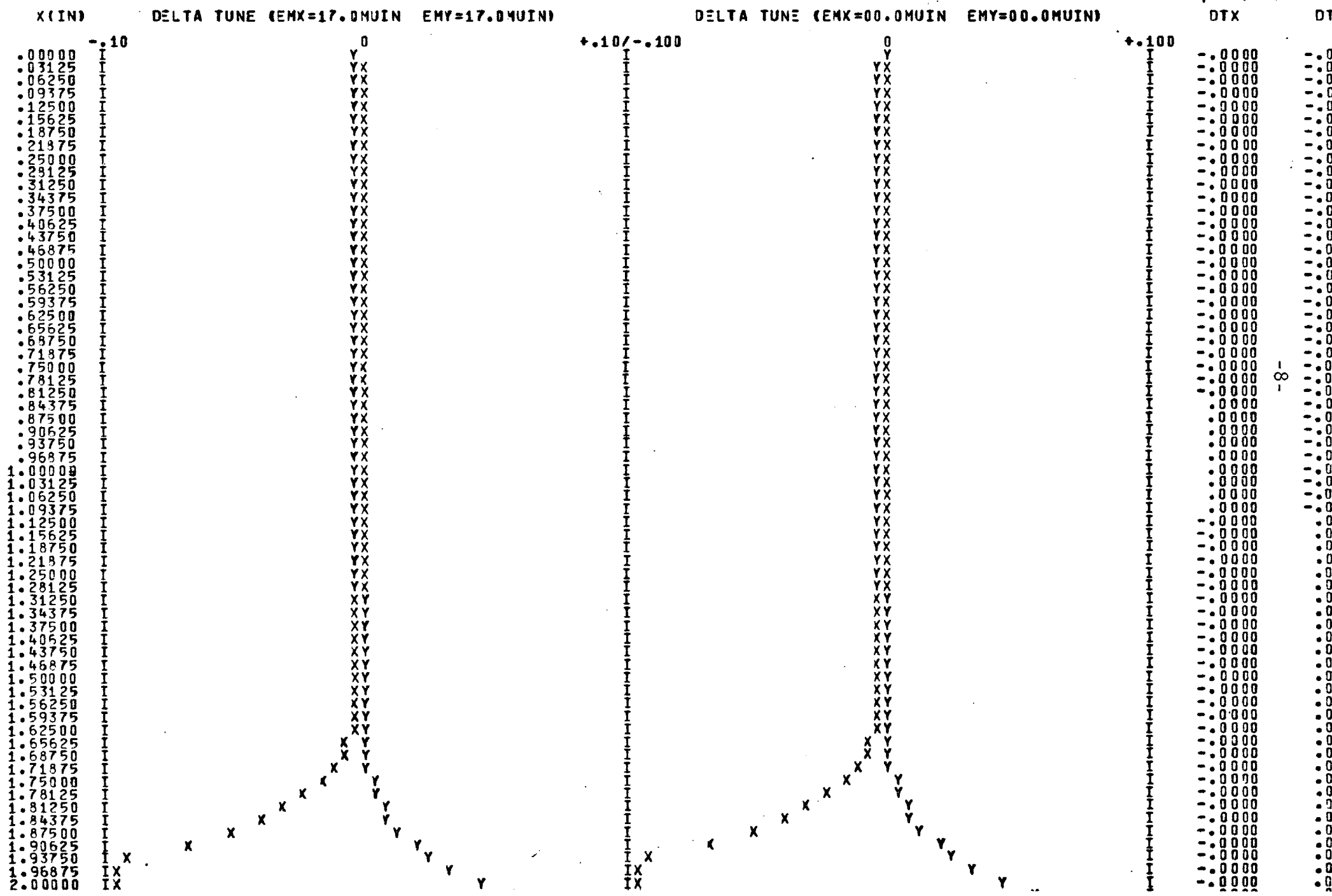
N	NET FIELD HY(KG-IN)	NET FIELD HX(KG-IN)	AIR FIELD HY(KG-IN)	AIR FIELD HX(KG-IN)	IRON CONTR. HY(KG-IN)	IRON CONTR. HX(KG-IN)	NORMALIZED FIELD HY/XGYO	NORMALIZED FIELD HX/XGYO
2	21.471609	0.000000	20.031542	0.000000	1.439967	0.000000	1.000000	0.000000
6	.001612	0.000000	.001558	0.000000	.000054	0.000000	.000075	0.000000
10	.000081	0.000000	.000081	0.000000	-.000000	0.000000	.000004	0.000000
14	.000004	0.000000	.000004	0.000000	-.000000	0.000000	.000000	0.000000
18	-.000001	0.000000	-.000001	0.000000	.000000	0.000000	-.000000	0.000000

MEDIAN PLANE FIELD VERSUS DISTANCE

X(IN)	NET FIELD HY(KG-IN)	NET FIELD HX(KG-IN)	AIR FIELD HY(KG-IN)	AIR FIELD HX(KG-IN)	IRON CONTR. HY(KG-IN)	IRON CONTR. HX(KG-IN)	NORMALIZED FIELD HY/XGYO	NORMALIZED FIELD HX/XGYO
.000	.000	0.000	.000	0.000	.000	0.000	1.000000	0.000000
.100	2.147	0.000	2.003	0.000	.144	0.000	1.000000	0.000000
.200	4.294	0.000	4.006	0.000	.288	0.000	1.000000	0.000000
.300	6.441	0.000	6.009	0.000	.432	0.000	1.000001	0.000000
.400	8.589	0.000	8.013	0.000	.576	0.000	1.000002	0.000000
.500	10.736	0.000	10.016	0.000	.720	0.000	1.000005	0.000000
.600	12.883	0.000	12.019	0.000	.864	0.000	1.000010	0.000000
.700	15.030	0.000	14.022	0.000	1.008	0.000	1.000018	0.000000
.800	17.178	0.000	16.026	0.000	1.152	0.000	1.000031	0.000000
.900	19.325	0.000	18.029	0.000	1.296	0.000	1.000051	0.000000
1.000	21.473	0.000	20.033	0.000	1.440	0.000	1.000079	0.000000
1.100	23.622	0.000	22.038	0.000	1.584	0.000	1.000118	0.000000
1.200	25.770	0.000	24.042	0.000	1.728	0.000	1.000173	0.000000
1.300	27.920	0.000	26.048	0.000	1.872	0.000	1.000247	0.000000
1.400	30.071	0.000	28.054	0.000	2.016	0.000	1.000346	0.000000
1.500	32.223	0.000	30.062	0.000	2.160	0.000	1.000475	0.000000
1.600	34.376	0.000	32.072	0.000	2.305	0.000	1.000632	0.000000
1.700	36.531	0.000	34.082	0.000	2.449	0.000	1.000801	0.000000
1.800	38.685	0.000	36.092	0.000	2.593	0.000	1.000923	0.000000
1.900	40.831	0.000	38.093	0.000	2.737	0.000	1.000848	0.000000
2.000	42.953	0.000	40.071	0.000	2.882	0.000	1.000231	0.000000
2.100	45.016	0.000	41.990	0.000	3.026	0.000	.998348	0.000000
2.200	46.942	0.000	43.772	0.000	3.171	0.000	.993753	0.000000

MAX. FIELD ON IRON(KG) = 14.6795 IRON PERMEABILITY AT BMAXFE= 564.6483 FLUX IN IRON(KG-IN) = 40.0530

011779-1500


X(IN)
DELTA TUNE (EMX=17.0MUIN EMY=17.0MUIN)
DELTA TUNE (EMX=00.0MUIN EMY=00.0MUIN)
DTX
-.10
0
+.10/-.100
0
+.100
.00000
.03125
.06250
.09375
.12500
.15625
.18750
.21875
.25000
.28125
.31250
.34375
.37500
.40625
.43750
.46875
.50000
.53125
.56250
.59375
.62500
.65625
.68750
.71875
.75000
.78125
.81250
.84375
.87500
.90625
.93750
.96875
1.00000
1.03125
1.06250
1.09375
1.12500
1.15625
1.18750
1.21875
1.25000
1.28125
1.31250
1.34375
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1.90625
1.93750
1.96875
2.00000