national accelerator laboratory

TM-435
0621.05

FIELD MEASUREMENTS ON LAMBERTSON SEPTUM MAGNETS

R. Juhala and D. Krause

September 20, 1973

Field measurements have been completed on four Lambertson septum magnets. Three of the magnets are type A and one is type B. The difference between the two types is the position of the zero field hole in the pole face through which the undeflected beam passes. Figure 1 shows in cross section a type A. The positive radial direction for purposes of this measurement is also shown. The points numbered 1-4 inside the undeflected beam aperture indicate the positions where the field therein was measured. The magnet was powered with a Transrex current regulated supply. Before measurements were made the magnets were cycled several times between 0 and 2500 A.

Point field measurements were made on Lambertson 13A. The data were taken well inside the aperture near the center of the pole. A calibrated search coil was used to sense the field. The absolute accuracy of these data is ±0.1% and are given in Table I.

Measurements of $\int Bdl$ as a function of current were made on all four magnets using a long two-turn stretched wire flip coil. The coil was centered in the magnet gap. The accuracy for currents above 500 A is ±0.1%. These results are given in Table II.

Measurements of the quantity $\int B(x)dl / \int B(x=0)dl$ were completed at various current levels. These results expressed in per cent of central

field (x = 0) are given in Table III(A-D). There is some deviation in the data from one magnet to another in the regions near the edge of the poles ($x \geq \pm 2.0$ in.). This is largely due to uncertainties in the probe position. The error in the data at points lying inside the region $x < \pm 2.0$ in. is less than 0.1%.

Measurements of the field inside the undeflected beam aperture were made using a "hand held" Hall probe. The points measured were well inside the magnet. These positions are indicated in Fig. 1. The component of field parallel to the strong component inside the magnet gap was measured. In general this component was equal to the absolute magnitude of the field. The field in this region was less than 25 G at currents up to 2000 A, with the same polarity as the strong components inside the gap.

Equipment List

1. Stretched wire flip coil - 2 turns of 0.004 in. tungsten wire separated by 0.5000 in. glass spacers; probe extended 3 ft beyond ends of magnet.
2. Philbrick Integrator which included 1 μf ± 0.1% capacitor, 30130 Ω input resistor plus 157 Ω coil resistance. Calculated calibration is 5.915 (kG-m)/V with S. W. coil.
3. Digital voltmeter: Dana Model 5900, NAL #12837; Dana Model 5500, NAL #2435.
4. Field box integrator which included 51 kΩ input resistor, 1 μf ± 0.1% capacitor and standard search coil calibrated at 0.4149 V/kG.
5. F. W. Bell gaussmeter Model 811AR, NAL #10864; F. W. Bell Hall Probe Model #HTL8-0618.

Table I. Point Field Measurements in Lambertson 13A Septum Magnet.

Current (A)	Field (kG)
200.2	1.026
400.2	2.047
600.8	3.068
800.0	4.102
1000.0	5.117
1200.0	6.132
1400.0	7.162
1600.0	8.175
1800.0	9.173
2000.0	10.148

Table II. Measurements of $\int$Bdl on Lambertson Septum Magnets.

Current (A)	Field (kG-m)			
	13A	14A	15A	16B
0	0.052	-	-	-
200	3.184	3.196	3.182	3.173
400	6.373	6.355	6.349	6.333
600	9.555	9.537	9.538	9.511
800	12.711	12.737	12.700	12.684
1000	15.888	15.884	15.870	15.855
1200	19.050	19.048	19.055	19.020
1400	22.201	22.196	22.196	22.187
1600	25.332	25.360	25.333	25.309
1800	28.434	28.444	28.442	28.426
2000	31.421	31.435	31.445	31.480

Table III. Measurements of a $= \int Bdl / \int B(x = 0)dl$ on Lambertson Septum Magnets.

A. Magnet #13A

x	R(1400 A)%	R(1600 A)%
+3.0	-52.45	-52.54
2.5	-15.29	-15.64
2.0	-0.14	-0.23
1.5	-0.18	-0.16
1.0	-0.05	-0.02
0.5	+0.01	+0.03
0.0	0.0	0.0
-0.5	-0.03	-0.05
-1.0	-0.08	-0.08
-1.5	-0.16	-0.15
-2.0	0.0	-0.08

B. Magnet #14A

x	R(1600 A)%	R(1800 A)%
+3.0	-52.26	-52.52
2.5	-15.23	-15.80
2.0	-0.27	-0.44
1.5	-0.17	-0.14
1.0	-0.03	+0.03
0.5	+0.02	+0.08
0.0	0.0	0.0
-0.5	-0.04	-0.07
-1.0	-0.08	-0.08
-1.5	-0.14	-0.12
-2.0	+0.03	-0.12

C. Magnet #15A

x	R(1600 A)%	R(1800 A)%
3.0	-52.41	-52.59
2.5	-15.36	-14.26
2.0	+0.80	+0.65
1.5	-0.02	+0.01
1.0	0.00	+0.06
0.5	+0.03	+0.07
0.0	0.0	0.0
-0.5	-0.03	-0.06
-1.0	-0.04	-0.05
-1.5	-0.01	+0.02
-7.0	+0.97	+0.84

Table III. Measurements of a $= \int Bdl / \int B(x = 0)dl$ on Lambertson Septum Magnets. (Continued)

D. Magnet #16B

x	R(1600 A)%	R(1800 A)%
+2.0	-0.60	-1.03
1.5	-0.27	-0.31
1.0	-0.10	-0.10
0.5	-0.02	-0.02
0.0	0.0	0.0
-0.5	-0.03	-0.04
-1.0	-0.15	-0.20
-1.5	-0.36	-0.48
-2.0	-0.57	-0.85
-2.5	-15.17[a]	-14.00
-3.0	-48.62	-50.12

[a]Questionable point due to possible error in probe position.

Table IV. Field Measurements Inside the Undeflected Beam Aperture.

A. Magnet #13A

Current (A)	Position 1	2	3	4 (Gauss)
1200	7	2	2	2
1400	7	1	1	2
1600	12	3	2	4
1800	20	4	3	5
2000	23	3	3	5

B. Magnet #16B

Current (A)	Position 1	2	3	4 (Gauss)
900	4	3	2	4
1300	8	7	4	6

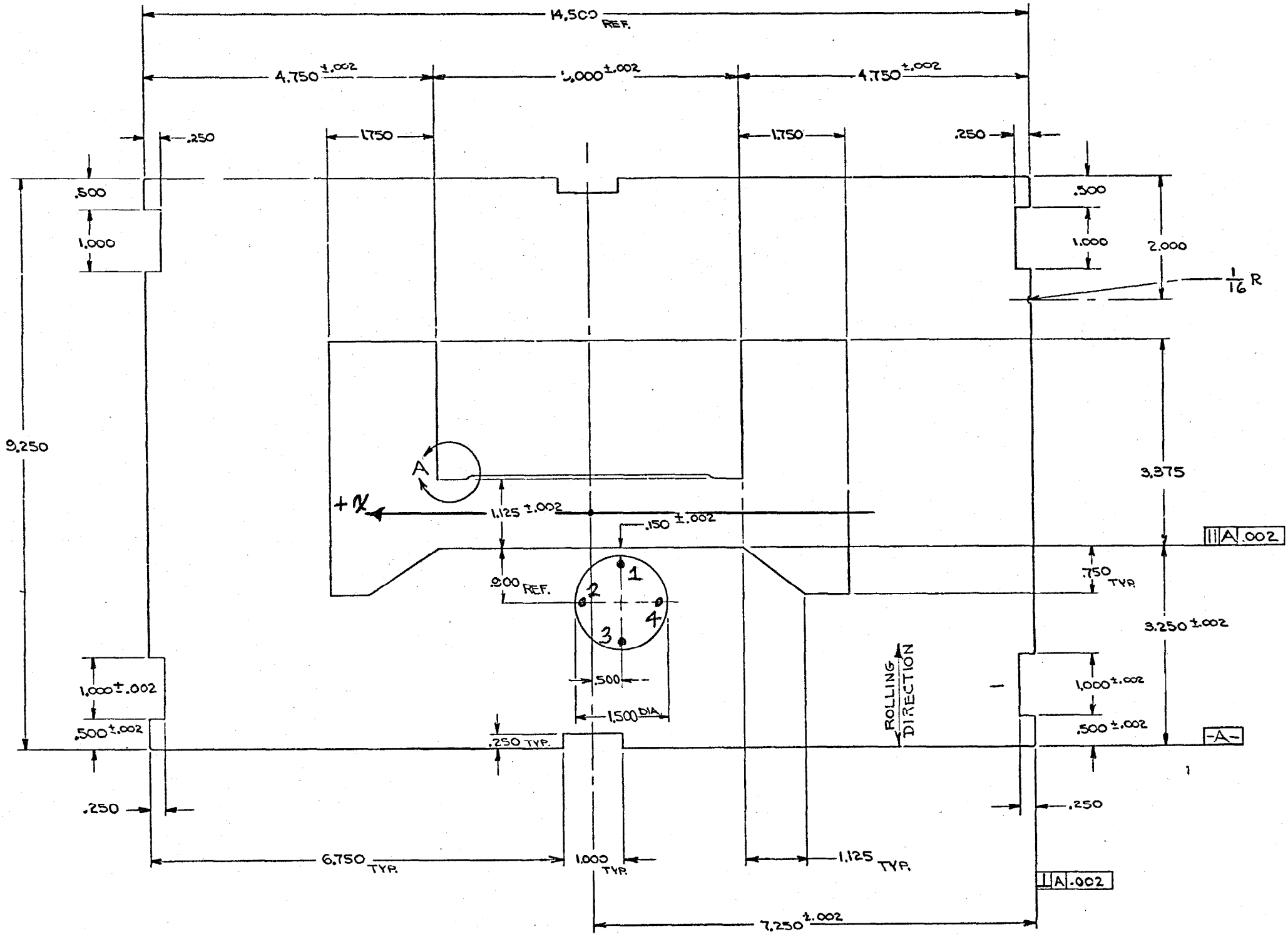

Fig. 1. Cross section of Lambertson II septum magnet, Type A
Type B has undeflected beam aperture 1.500 in. from the center of the gap.