BROOKHAVEN NATIONAL LABORATORY

MAGNET DIVISION NOTES

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Date: August 29, 1991

No: 391-16(RHIC-MD-118)

Task Force: RHIC

Title: Current Requirements in RHIC Insertion Quadrupole

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Current Requirements in RHIC Insertion Quadrupole

Ramesh Gupta

In this note we give the approximate values of current required in various quadrupoles in RHIC insertion lattice RHIC91. Please note that these are computed for power supply design consideration purpose where an approximate value is enough to devise design strategy. Moreover, in the case of 13 cm aperture quadrupole, an earlier cross section design was used. Newer design has a slightly different transfer function and therefore the absolute value of current would change accordingly; however, the relative would not change significantly.

In the enclosed four tables, we have included the gradient and current requirements in various quadrupoles. The table 1 and table 2 are for the inner and outer ring respectively (except for the 6 O'clock interaction region); table 3 and table 4 are for the inner and outer ring for the 6 O'clock interaction region. We have also included the bore diameter (in cm) and the length of the magnets (in meter) for reference. Cottingham and Lambiase are discussing the possibilities of decreasing the length of Q6 and Q9 from 1.13 m to 0.95 m. In that case the gradient and current in those magnets would go up in the same proportion. We have also included the gradient versus current function values in the same table for cross checking purpose.

Table 1

Ramesh Gupta
July 25, 1991

Approximate Values of Gradient and Current Requirement in the RHIC Insertion Quadrupoles for Various Values of BETA* at Crossing Point

INNER LAYER (Except 6 O'clock)

Currents (kAmps)

BETA*	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Bore-->	13	13	13	8	8	8	8	8	8
Eff L->	1.44	2.41	1.44	1.5	1.5	1.13	1.5	1.13	1.13
2	5.58	5.86	4.91	4.68	3.82	2.87	4.40	4.91	4.17
3	5.53	5.81	4.86	4.52	4.70	3.80	4.52	4.94	4.01
4	5.51	5.78	4.82	4.34	5.23	3.97	4.62	4.98	3.84
5	5.51	5.78	4.81	4.27	5.60	3.88	4.65	4.99	3.73
6	5.49	5.78	4.82	4.23	5.90	3.81	4.64	4.99	3.64

Gradients (Tesla/meter)

BETA*	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
2	54.9	57.5	48.6	69.1	56.6	42.5	65.0	72.4	61.6
3	54.4	57.0	48.1	66.8	69.4	56.3	66.7	72.8	59.3
4	54.2	56.7	47.7	64.1	77.0	58.7	68.2	73.4	56.9
5	54.2	56.7	47.6	63.1	81.9	57.4	68.6	73.6	55.3
6	54.0	56.7	47.7	62.6	86.0	56.4	68.5	73.5	54.0

Gradient Vs. Current used in above calculations :

<---- 8 cm ------->	
I(ka)	Grad(T/m)
1.0	14.818
3.0	44.450
4.0	59.237
5.0	73.716
6.0	87.376
7.0	100.30

<--- 13 cm --->	
I(kA)	Grad(T/m)
1.0	9.938
3.0	29.813
4.0	39.716
5.0	49.444
5.5	54.149
6.0	58.681
7.0	67.211
8.0	75.283
9.0	83.036

Table 2

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July 25, 1991

Approximate Values of Gradient and Current Requirement in the RHIC Insertion Quadrupoles for Various Values of BETA* at Crossing Point

OUTER LAYER (Except 6 O'clock)

Currents (kAmps)

BETA*	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Bore-->	13	13	13	8	8	8	8	8	8
Eff L->	1.44	2.41	1.44	1.5	1.5	1.13	1.5	1.13	1.13
2	5.58	5.86	4.91	4.68	3.78	2.83	4.40	4.92	4.20
3	5.53	5.81	4.86	4.52	4.65	3.77	4.52	4.95	4.04
4	5.51	5.78	4.82	4.34	5.20	3.94	4.61	4.99	3.86
5	5.51	5.78	4.81	4.27	5.58	3.86	4.65	5.00	3.74
6	5.49	5.78	4.82	4.23	5.87	3.78	4.64	5.00	3.66

Gradients (Tesla/meter)

BETA*	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
2	54.9	57.5	48.6	69.1	56.0	41.9	65.0	72.5	62.0
3	54.4	57.0	48.1	66.8	68.7	55.8	66.7	72.9	59.8
4	54.2	56.7	47.7	64.1	76.6	58.3	68.1	73.5	57.2
5	54.2	56.7	47.6	63.1	81.6	57.1	68.6	73.7	55.5
6	54.0	56.7	47.7	62.6	85.6	56.0	68.5	73.6	54.3

Gradient Vs. Current used in above calculations :

<---- 8 cm ------->	
I(ka)	Grad(T/m)
1.0	14.818
3.0	44.450
4.0	59.237
5.0	73.716
6.0	87.376
7.0	100.30

<--- 13 cm --->	
I(kA)	Grad(T/m)
1.0	9.938
3.0	29.813
4.0	39.716
5.0	49.444
5.5	54.149
6.0	58.681
7.0	67.211
8.0	75.283
9.0	83.036

Table 3

Ramesh Gupta
Aug 27, 1991

Approximate Values of Gradient and Current Requirement in the RHIC Insertion Quadrupoles for Various Values of BETA* at Crossing Point

-----> 6 O'clock (INNER)

Currents (kAmps)

BETA*	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Bore-->	13	13	13	13	13	13	8	13	8
Eff L->	1.44	2.41	1.44	2.41	2.41	1.44	1.5	1.44	1.13
2	6.61	6.05	4.51	4.76	4.14	4.26	4.29	5.64	4.19
3	5.77	5.88	4.80	4.23	4.47	4.45	4.45	5.72	4.04
4	5.60	5.83	4.82	4.04	4.92	4.65	4.54	5.76	3.89
5	5.76	5.84	4.75	3.90	5.31	4.80	4.56	5.76	3.78
6	5.88	5.84	4.73	3.73	5.67	4.93	4.54	5.72	3.69

Gradients (Tesla/meter)

BETA*	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
2	63.9	59.1	44.7	47.1	41.1	42.2	63.5	55.4	62.0
3	56.6	57.6	47.5	42.0	44.3	44.1	65.7	56.1	59.8
4	55.1	57.1	47.7	40.1	48.7	46.0	67.1	56.5	57.7
5	56.5	57.2	47.0	38.7	52.4	47.5	67.4	56.5	56.1
6	57.6	57.2	46.8	37.1	55.7	48.8	67.1	56.1	54.7

Gradient Vs. Current used in above calculations :

<---- 8 cm ------->	
I(ka)	Grad(T/m)
1.0	14.818
3.0	44.450
4.0	59.237
5.0	73.716
6.0	87.376
7.0	100.30

<--- 13 cm --->	
I(kA)	Grad(T/m)
1.0	9.938
3.0	29.813
4.0	39.716
5.0	49.444
5.5	54.149
6.0	58.681
7.0	67.211
8.0	75.283
9.0	83.036

Table 4

Ramesh Gupta
Aug 27, 1991

Approximate Values of Gradient and Current Requirement in the RHIC Insertion Quadrupoles for Various Values of BETA* at Crossing Point

-----> 6 O'clock (OUTER)

Currents (kAmps)

BETA*	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Bore-->	13	13	13	8	8	8	8	13	8
Eff L->	1.44	2.41	1.44	1.5	1.5	1.13	1.5	1.44	1.13
2	6.61	6.05	4.51	5.14	4.47	3.56	4.37	5.76	4.16
3	5.77	5.88	4.80	4.56	4.55	3.58	4.53	5.90	4.22
4	5.60	5.83	4.82	4.36	4.99	3.74	4.63	5.96	4.11
5	5.76	5.84	4.75	4.21	5.37	3.86	4.66	5.96	4.04
6	5.88	5.84	4.73	4.03	5.67	3.94	4.64	5.94	4.00

Gradients (Tesla/meter)

BETA*	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
2	63.9	59.1	44.7	75.7	66.1	52.7	64.6	56.5	61.6
3	56.6	57.6	47.5	67.4	67.2	53.0	66.9	57.8	62.4
4	55.1	57.1	47.7	64.4	73.6	55.4	68.4	58.3	60.9
5	56.5	57.2	47.0	62.3	78.8	57.1	68.8	58.3	59.8
6	57.6	57.2	46.8	59.6	82.9	58.3	68.5	58.1	59.2

Gradient Vs. Current used in above calculations :

<---- 8 cm ------->		<--- 13 cm --->	
I(ka)	Grad(T/m)	I(kA)	Grad(T/m)
1.0	14.818	1.0	9.938
3.0	44.450	3.0	29.813
4.0	59.237	4.0	39.716
5.0	73.716	5.0	49.444
		5.5	54.149
6.0	87.376	6.0	58.681
7.0	100.30	7.0	67.211
		8.0	75.283