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Optimization Of The Lattice For Intrabeam Scattering For Short Bunches Operation Mode (90 Degree Advance Cell)

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RHIC-PG-7

OPTIMIZATION OF THE LATTICE FOR INTRABEAM SCATTERING FOR SHORT BUNCHES OPERATION MODE (90° PHASE ADVANCE CELL)

A.G. Ruggiero

(BNL, November 21, 1983)

Same procedure as in RHIC-6
Same beam bunch parameters
This time we assume a regular FODO cell with 90° phase advance.

For the quadrupole gradient B'

$$\frac{B' \ell_Q}{B\rho} L = \sqrt{2} \qquad (1)$$

the symbols here and in the following having the same meaning as in RHIC-6.
Also

$$\beta_{max} = (2+\sqrt{2})\,L$$
$$\beta_{min} = (2-\sqrt{2})\,L \qquad (2)$$

$$\eta_{max} = (2+1/\sqrt{2})\,L\theta$$
$$\eta_{min} = (2-1/\sqrt{2})\,L\theta \qquad (3)$$

with the average values

$$\bar{\beta} = 2L \qquad (4)$$
$$\bar{\eta} = 2L\theta \qquad (5)$$

As in RHIC-6, the number of half-cells is

$$N = 2\pi R_o / L \qquad (R_o = 381.2325\ m)$$

and the bending angle per half regular cell

$$\theta = 2\pi / N$$

Therefore eq. (5) can be replaced with

$$\bar{\eta} = 2 \frac{L^2}{R_o} \qquad (6)$$

The results, as in RHIC-6, are given in the Table at the end of the paper.

In this table we have marked with a star our choice which corresponds to a luminosity lifetime well in excess of one hour and a full cell length

$$2L = 30\ m$$

For this cell length

$$\beta_{max} = 51\ m$$
$$\eta_{max} = 1.6\ m$$

Also

$N = 160$
$\theta = 39.27$ mrad

Again we take same parameters as in RHIC-6 at 5GeV/A, the maximum beam full height is

$a_V = 12.8$ mm

and the maximum full width is

$a_H = 13.2$ to 16.0 mm

These numbers corresponds to about 5 standard deviations.

We show in a second table the same calculation for an initial rms energy spread $\sigma_E/E = 2\times10^{-4}$. As one can see the luminosity lifetime is reduced down to 1/3 of the previous value and the allowable coupling impedance is down to 1/4 of the original value.

Sketch of a Regular Cell (Approximated)

Take $L = 15$ m

Quadrupole length $\ell_Q = 1.5$ m

$B\rho$ for Gold at 100 GeV/A = 800 T-m

Quadrupole Gradient = 50.3 T/m

Bore Radius = 4 cm

Field at Pole Tip = 2.0 T

$N = 160$ half-cells

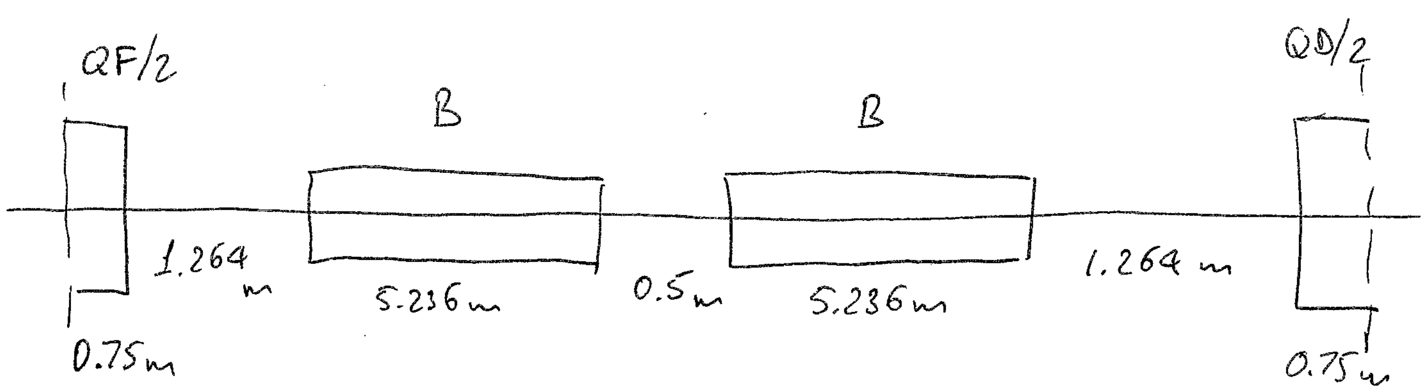
$\theta = 39.27$ mrad, bending angle / half-cell

Take $B = 3.0$ T

Make 2 dipoles per half a cell

then $2\,\ell_B = 10.472$ m

that is $\ell_B = 5.236$ m



$\sigma_E/E = 4 \times 10^{-4}$

L	$\bar{\beta}$	$\bar{\eta}$	τ_E^{-1}	τ_β^{-1}	t_L	γ_T	Z/n	
m	m	m	h^{-1}	h^{-1}	hours		ohm	
2.5	5	0.033	–	–	–	136	0.77	
5.	10	0.131	–	–	–	68	2.	
7.5	15	0.295	–	–	–	45	6.6	
10.	20	0.525	.0036	.0020	1.5	34	13	
12.5	25	0.82	.0028	.0013 / .0051	2. / 1.0	27.3	21	
15.	30	1.18	.0024	.0037	1.37	22.7	31	*
17.5	35	1.61	.0020	.0060	1.0	19.5	42	
20.	40	2.10	.0017	.0078	0.9	17.	56	
22.5	45	2.66	.0014	.0092	0.8	15.	73	
25.	50	3.28	.0011	.0120	0.64	13.6	89	

$\sigma_E / E = 2 \times 10^{-4}$

L	$\bar{\beta}$	$\bar{\eta}$	τ_E^{-1}	τ_β^{-1}	t_L	γ_T	Z/n	
m	m	m	h^{-1}	h^{-1}	hours		ohm	
2.5	5	.033	–	–	–	136	0.19	
5	10	0.131	–	–	–	68	0.5	
7.5	15	0.295	–	–	–	45	1.7	
10	20	0.525	0.0195	0.0027	0.4	34	3.2	
12.5	25	0.82	0.0162	0.0018 / .0074	0.5/0.35	27.3	5.2	
15	30	1.18	0.0144	0.0055	0.4	22.7	7.7	*
17.5	35	1.61	0.0123	0.0092	0.4	19.5	10.5	
20	40	2.10	0.0107	0.0126	0.36	17	14	
22.5	45	2.66	0.0094	0.0154	0.34	15	18.2	
25	50	3.28	0.0081	0.0178/0.0229	0.32/0.27	13.6	22.2	