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

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

A.G. Ruggiero

(BNL, November 21, 1983)

①

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'

$$\frac{B' l_Q}{B \rho} L = \sqrt{2} \quad (1)$$

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

Also

$$\begin{aligned} \beta_{\max} &= (2 + \sqrt{2}) L \\ \beta_{\min} &= (2 - \sqrt{2}) L \end{aligned} \quad (2)$$

$$\begin{aligned} \eta_{\max} &= (2 + 1/\sqrt{2}) L \theta \\ \eta_{\min} &= (2 - 1/\sqrt{2}) L \theta \end{aligned} \quad (3)$$

with the average values

$$\bar{\beta} = 2 L \quad (4)$$

$$\bar{\eta} = 2 L \theta \quad (5)$$

(2)

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

$$N = 2\pi R_0 / L \quad (R_0 = 381.2325 \text{ m})$$

and the bending angle per half regular cell

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

Hence eq. (5) can be replaced with

$$\bar{\eta} = 2 \frac{L^2}{R_0} \quad (5)$$

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

$$2L = 30 \text{ m}$$

For this cell length

$$\beta_{\text{max}} = 51 \text{ m}$$

$$\eta_{\text{max}} = 1.6 \text{ m}$$

Also

$$N = 160$$

$$\theta = 39.27 \text{ mrad}$$

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

$$a_v = 12.8 \text{ mm}$$

and the maximum full width is

$$a_H = 13.2 \text{ to } 16.0 \text{ mm}$$

These numbers corresponds to about 5 standard deviations.

We show in a second table the same calculation for an initial rms energy spread $\sigma_E/E = 2 \times 10^{-4}$ - as one can see the luminosity lifetime is reduced down to $\frac{1}{3}$ of the previous value and the allowable coupling impedance is down to $\frac{1}{4}$ of the original value.

Sketch of a Regular Cell (Approximated)

Take $L = 15 \text{ m}$

Quadrupole length $l_q = 1.5 \text{ m}$

$B\rho$ for Gold at $100 \text{ GeV/A} = 800 \text{ T}\cdot\text{m}$

Quadrupole Gradient = 50.3 T/m

Bore Radius = 4 cm

Field at Pole Tip = 2.0 T

$N = 160$ half-cells

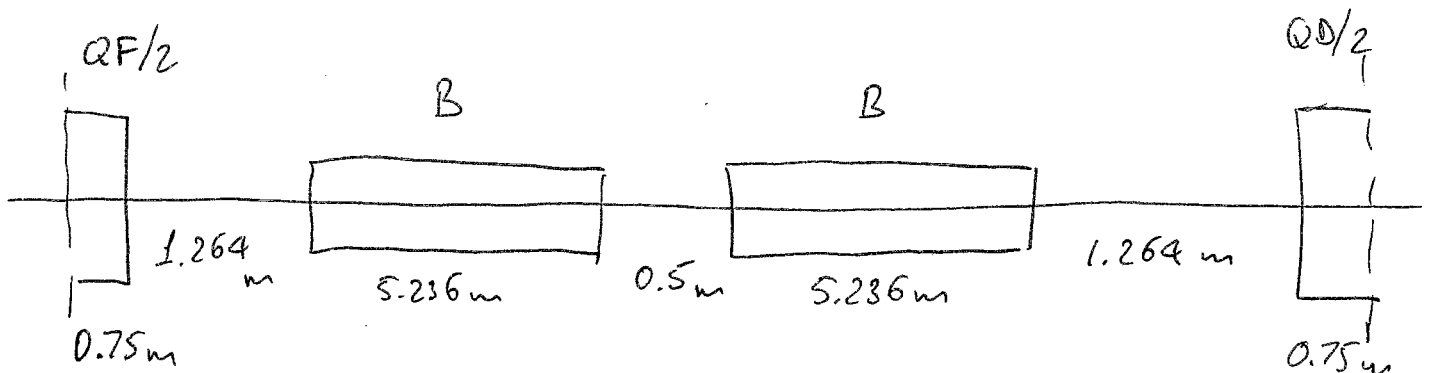
$\theta = 39.27 \text{ mrad}$, bending angle / half-cell

Take $B = 3.0 \text{ T}$

Make \geq dipoles per half a cell

then $2 l_B = \text{~~10.472 m~~ } 10.472 \text{ m}$

that is $l_B = 5.236 \text{ m}$



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

(5)

L	$\bar{\beta}$	$\bar{\eta}$	α_E^{-1}	α_{β}^{-1}	t_L	δ_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	

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

(6)

L	$\bar{\beta}$	$\bar{\eta}$	τ_E^{-1}	τ_B^{-1}	t_L	γ_T	Z/n	
m	m	m	h ⁻¹	h ⁻¹	hours		ahms	
2.5	5	0.33	-	-	-	136	0.19	
5	10	0.181	-	-	-	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 / 0.0074	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	