BNL-101550-2014-TECH

RHIC/PG/7;BNL-101550-2013-IR

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

A. G. Ruggiero

November 1983

Collider Accelerator Department

Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

DISCLAIMER

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

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

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

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

and the bending angle per half regular cell

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

Therefore eq. (5) can be replaced with

$$\bar{\eta} = 2 \frac{L^2}{R_0} \qquad (6)$$

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

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

For this cell length

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

Also

$$N = 160$$
$$\theta = 39.27 \text{ mrad}$$

Again we take same parameters as in RHIC-6 at 5GeV/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 $\sigma_E/E = 2\times10^{-4}$. 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 $\qquad l_Q = 1.5$ m

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

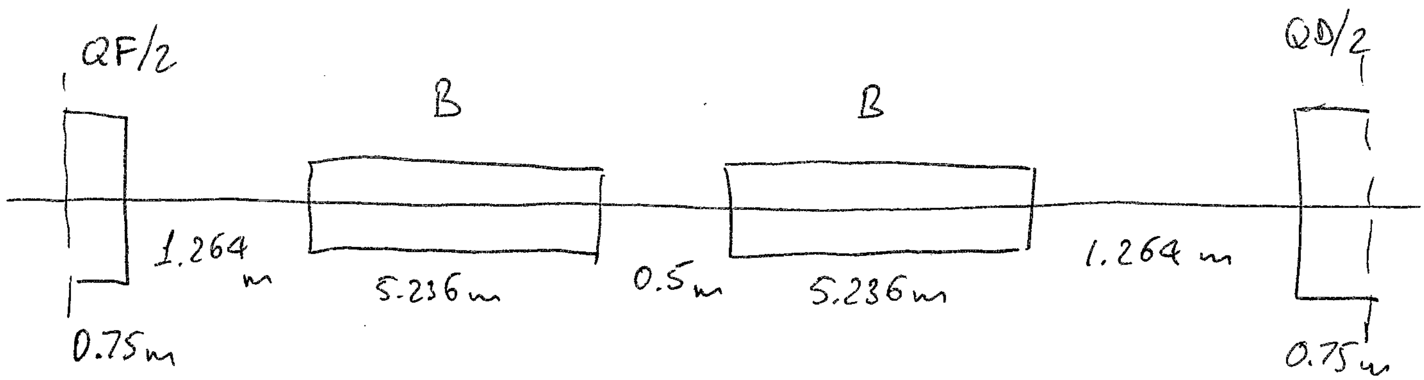
Quadrupole Gradient $=$ 50.3 T/m
Bore Radius $=$ 4 cm
Field at Pole Tip $=$ 2.0 T

$N = 160$ half-cells
$\theta = 39.27$ mrad, bending angle / half-cell

Take $B = 3.0$ T
Make 2 dipoles per half a cell

then $\qquad 2\, l_B = 10.472$ m

that is $\qquad l_B = 5.236$ 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	