BNL-101660-2014-TECH
RHIC/AP/4;BNL-101660-2013-IR

A Preliminary Lattice for RHIC with 20 cm Beam Separation in the Arc and 30 cm Beam Separation in the Straight Section

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August 1984

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BNL, August 8, 1984

A reference design of the RHIC lattice described in the RHIC proposal[1] has the 30 cm. beam-beam separation in the arc and insertion regions. There are reasons from the cost and construction point of view to design a lattice with 20 cm beam-beam separation in the arc region while maintaining 30 cm beam-beam separation in the straight experimental section. This short note is intended to investigate the feasibility of such a lattice design. Some important features of the original RHIC lattice have been fully retained, e.g. (1)long dispersion free straight section; (2) integral multiple of 2π in the phase advance through the insertion region; (3) the length of L_{12} and L_{67} are long enough for possible beam dump and beam injection respectively; (4) β_H^{max} and β_V^{max} should be less or equal to 300 m for the aperture requirement; (5) β_H^* and β_V^* at the crossing point should be as small as possible.

A simple modification to the original lattice is to move the dispersion suppressor set BS Q5 BS of the inner insertion away from the crossing point while the corresponding set of the outer insertion toward the crossing point[2]. Through this arrangement, we reach a preliminary solution,which gives:

$\beta_H^* \times \beta_V^* = 0.95\text{m} \times 8.83\text{m}$

$\beta_H^{max}(QC) = 282.4\text{m}$

$\beta_V^{max}(Q1) = 242.5\text{m}$

$\beta_V^{max}(Q5) = 255\text{m}$

The strength of the focusing magnets are given by the following table:

Quads	Inner insertion	Outer insertion
QC	.13339581	.13339581
Q1*	.07968545	.07968545
Q1	.02916885	.03112382
Q2	.10503435	.09662240
Q3	.12894909	.13012411
Q4	.10004414	.10959580
Q5	.09751903	.09433017
Q6	.11334441	.11001080
Q7	.15359849	.15043661
Q8	.04495559	.04521152

where the strength of the quadrupoles is expressed in the unit of meter^{-2}. The betatron function and the dispersion function in the insertion region are shown in Fig.1.

Comparing the present preliminary lattice to the RHIC design, we observe that the luminosity is about 2/3 of the original reference design, however $\beta^{max}_{H,V}$ here is also reduced by about 10-20%. We conclude from the present study that a lattice of reasonable quality for 20 cm arc beam-beam separation and 30 cm beam-beam separation in the long straight section is feasible. More work is still needed if the magnet design favors this choice.

References

1. RHIC and Quark matter, Preliminary RHIC proposal, BNL-51801

2. J. Claus, Private communication.