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A RHIC Lattice with Reversed Quadrupole Polarity

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High Energy Facilities

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1. Introduction

A RHIC lattice has been worked out in detail on various issues of accelerator physics.[1,2] For the injection consideration from the AGS, it may be preferable to place the kicker at a focusing quadrupole on the plane of injection. This short note is to demonstrate that the lattice solution exists for that purpose.

2. Lattice Functions

The essence of the present lattice is the same as that of ref. 1. However, the inner arc cells are arranged from the defocusing quadrupole to the defocusing quadrupole. The insertion attached to the inner arc is from defocusing quadrupole (Q9I) to the outer focusing quadrupole (Q9O). Then the continued outer arc cells are from the focusing quadrupoles to the focusing quadrupole. Figure 1 shows the quadrupole distribution in the insertion and the corresponding lattice functions.

The injection complex from AGS locates between Q8 and Q9 in the outer insertion, where Q9 is a horizontally focusing quadrupole element.

3. Injection-ejection Consideration

The kicker strength is given by

$$\Delta x' = \frac{\Delta x}{\sqrt{\beta_S \cdot \beta_K} \sin \Delta\mu_{SK}} \qquad (1)$$

where β_S, β_K are ~~be~~ta functions at the location of the septum magnet and the kicker respectively, $\Delta\mu_{SK}$ is the phase advance between the septum and the kicker and Δx is the distance between the centers of the injection beam and the stored circulating beam at the septum location.

The present geometry has one advantage: smaller x_p (0.8 m) and β_x at the location of septum and larger β_x at the location of the kicker. Thus the kicker strength needed may be somewhat smaller than the lattice considered in refs. 1 and 2.

As to the ejection of the beam, the location between Q3 and Q5 seems to be a possible candidate. The leverage arm for the ejection kicker is $L_A = \sqrt{\beta_K \beta_D} \sin\Delta\mu_{KD}$ where β_K, β_D and $\Delta\mu_{KD}$ are the beta functions at the kicker, the internal beam dump and the phase advance between them. The phase advance $\Delta\mu_{KD}$ is approximately 45° in both planes. We shall calculate the length of kicker leverage arm. We use the transfer matrix approach as

$$\begin{pmatrix} 1 & L_K \\ 0 & 0 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ -1/f_4 & 1 \end{pmatrix} \begin{pmatrix} 1 & L_D \\ 0 & 1 \end{pmatrix} = \begin{pmatrix} a & L_A \\ c & b \end{pmatrix}$$

where f_4 is the focal length of Q4, L_K is the distances between the Q4 and the kicker (ejection), L_D is the distance between Q4 and the beam dump, and L_A is the leverage arm length, which

$$L_A = L_K + L_D - \frac{L_K L_D}{f_4}$$

For example, let us consider the inner arc where kicker are placed at L_K = 38 m from Q4I and the beam dump at L_D = 6 m from the Q4I. The focal length of Q_4 is +20.5 m horizontally and -20.5 m vertically. The leverage arm length becomes

$$L_A = \begin{cases} 33 \text{ m} & \text{horizontal} \\ 55 \text{ m} & \text{vertically} \end{cases}$$

We also observe that the vertical beam size at the kicker is about 40% more than that horizontally. Further detail analysis may prove that the vertical ejection between Q3 and Q5 is a possible candidate for the RHIC internal beam dump.

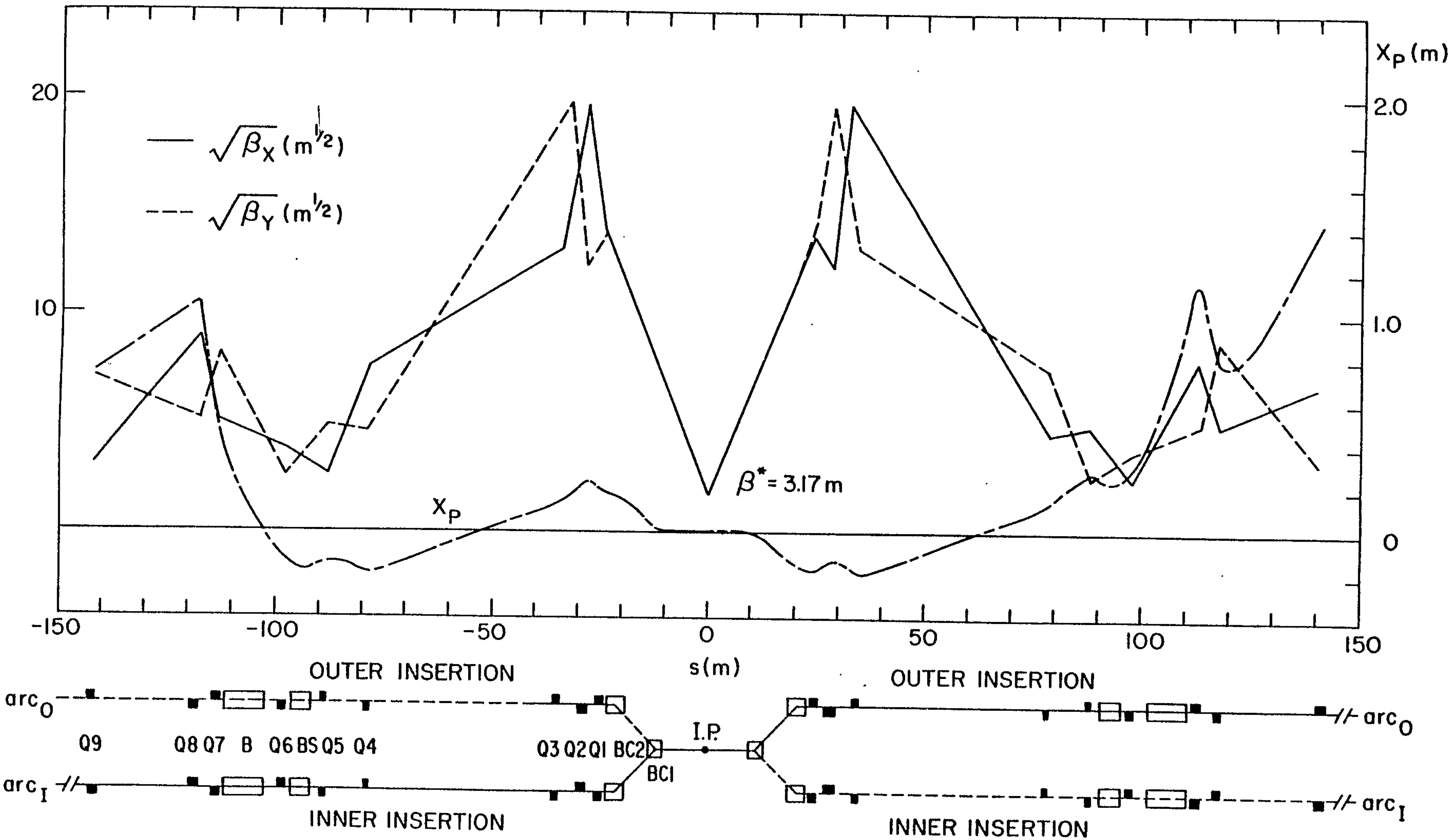
4. Conclusion

This short note aims to prove the existence of an alternative RHIC ring structure. Careful injection scheme should be studied and compared between the standard RHIC lattice and the present alternative solution. The beam dynamic properties are expected to be similar to that of ref. 1.

References

1. S. Y. Lee, J. Claus, E. D. Courant, H. Hahn and G. Parzen, "The RHIC Lattice", BNL 36563, and the Proceedings of the 1985 Particle Accelerator Conference, Vancouver, B.C., Canada, IEEE Trans. Nucl. Sci. NS-32, No. 5, 1626 (1985).

2. "Proposal for a Relativistic Heavy Ion Collider", BNL 51932.



Betatron and Dispersion Functions in the Insertion Region.