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## RHIC Correction System, Reduction in Power Supplies

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Introduction

This note summarizes the suggested temporary reduction in the power supplies for the RHIC Correction System in order to bring down the cost of the power supplies. These proposed reductions are first briefly summarized; then some detailed considerations are given of the effects of these changes.

The power supplies for the random quadrupole  $a_1/b_1$  correction system are omitted. The only remaining random  $b_1$  correction is that provided by the insertion quadrupoles. The only remaining random  $a_1$  correction is the 2 power supplies for the coupling correction system. Note the coupling correction system, having 2 families of  $a_1$  quads in the insertions, is considered as being separate and distinct from the random quadrupole  $a_1/b_1$  correction system which has 36 families, mostly in the arcs.

The power supplies for the insertion quads are considerably reduced due to the following assumptions.

- 1) The machine operates with  $\beta^* = 6$  at all energies.
- 2) The  $\nu$ -values can be varied by  $\pm .25$ .

The excitation of all the insertion quads can be individually varied. The power supplies are large enough to provide for a  $\nu$ -variation of  $\pm .25$ , plus about 2% current variation to control  $\beta_x$ ,  $\beta_y$  and  $X_p$  at the crossing points, plus the amount required by the differences in excitation of inner and outer quads of the same type (e.g. Q11 and Q10)

The closed orbit correction system power supplies are reduced in number by a factor 2 in the arcs only. The quad bypass current strength is reduced from 1500A to 500A. The BS11 and BS10 will have different lengths and will not have separate power supplies.

### Philosophy

The potential of the correction system will not be reduced - all leads and coils will be provided; only power supplies will be omitted.

### Dangers

Predictable effects are not a problem - unpredictable effects (e.g. beam-beam interaction) are, when things go wrong, it won't be easy to restore power supplies.

### $a_1/b_1$ System

#### Effects of Random $a_1/b_1$

- 1) Random  $\Delta\beta_x/\beta_x$ ,  $\Delta\beta_y/\beta_y$ ,  $X_p$ ,  $Y_p$ .
- 2) Loss in aperture  $\sqrt{\pm 4}$  mm (depends on choice of  $v_y, v_y$  - may be larger).  
Reduced aperture reduces beam lifetime, not luminosity so much.
- 3) Loss in luminosity - larger beam size at crossing point.
- 4) Increased beam-beam interaction - random  $\Delta v_{\text{beam-beam}} \approx 30\%$ , may be more.

### $b_1$ Correctors

$N_0$   $b_1$  in arcs.

$b_1$  correction in insertion  $\approx 2\%$  to control  $\Delta\beta/\beta$  and  $X_p$  at crossing point.

(Based on CBA study.)

Tracking study needed to see effect of random  $b_1$  on aperture.

Synch study needed to find  $b_1$  - correction needed to correct  $\Delta\beta/\beta$  and  $X_p$  at crossing point.

a<sub>1</sub> correction

a<sub>1</sub> generates coupling and Y<sub>p</sub> (vertical dispersion).

Full coupling correction provided

2 power supplies for a<sub>1</sub> in insertions. a<sub>1</sub> near Q2 → Q3

Y<sub>p</sub> Correction at crossing point

No a<sub>1</sub> coils used.

Use vertical displacement of the closed orbit to correct Y<sub>p</sub>.

( $\Delta Y_{co} \approx \pm 5$  mm.)

Do we have enough y-space?

For  $\gamma \approx 30$ , no dispersion gives 7.5 mm space; also  $t \leq 10$  hrs. has more vertical space.

For  $\gamma > 30$  more space as beam shrinks.

This is a complicated question - but some correction of Y<sub>p</sub> seems possible

a<sub>0</sub>/b<sub>0</sub> closed orbit

Use CBA experience - reduce power supplies in arcs by 1/2 in number, removes 144 power supplies. This needs a computer simulation study to determine the quality of the closed orbit correction with the reduced number of power supplies.

Insertion quads

All have (effectively) individual trims to give  $\Delta v = \pm .25$ , plus 2% current variation for controlling  $\Delta\beta/\beta$  and  $\Delta X_p$  at crossing point, plus the current required to provide the small unequal excitation of the insertion quadrupoles in the inner and outer arcs.

The 2% for controlling  $\Delta\beta/\beta$  and  $X_p$  at the crossing points was derived from the CBA experience where 4% was found to be required - and 2% is 1/2 of the required amount. This 2% number needs to be checked for RHIC by doing a SYNCH study.

Quad Bypass

Reduce current 1500A  $\rightarrow$  500A, which allows  $\Delta v > \pm 1$ .

BS1

BS1 will have different lengths for BS1I and BS1O - they will have the same excitation as the normal dipoles and produce the required  $\int B d\ell$  within an error of a few parts in  $10^4$ .

BC2

Increase current,  $I = 2000A \rightarrow 2400A$

The above work represents the results of the combined efforts of the Correction System Committee which includes J. Claus, G. Cottingham, G. Dell, H. Hahn, J. Herrera, S.Y. Lee, G. Parzen, R. Shutt and P. Thompson.