The Dependence of the Dynamic Aperture on $\beta^*$ in RHIC

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Tracking studies were done to study the dependence of the dynamic aperture of $\beta^*$, the beta function at the crossing points, in RHIC92. RHIC92 can be tuned over a wide range$^1$ of $\beta^*$, roughly $\beta^* = 1$ to $\beta^* = 16$. For low $\beta^*$, $\beta^* \approx 2$, one expects the dynamic aperture to increase with $\beta^*$ roughly like $\sqrt{\beta^*}$. However at higher $\beta^*$, $\beta^* \geq 6$, the dynamic aperture increases fairly slowly with $\beta^*$. This is shown in Fig. 1 where the dynamic aperture as measured by $A_{SL}$ is plotted against $\beta^*$. $\beta^*$ is assumed to be the same at all six crossing points. Tracking runs for 1000 turns at $\Delta p/p = 0$ were done to find $A_{SL}$.

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![Fig. 1: Dynamic aperture versus $\beta^*$.]
At low $\beta^*$, $\beta^* \sim 2$, the dynamic aperture is dominated by the high beta magnets in the insertions, Q2, Q3 and D0. In this region the dynamic aperture increases roughly like $\sqrt{\beta^*}$ since the beta function in the high beta magnets goes roughly as $1/\beta^*$. For higher $\beta^*$, $\beta^* > 6$, the beta function in the high beta magnets has decreased sufficiently that the arc magnets begin to dominate. In this region the dynamic aperture does not change much with $\beta^*$, as changing $\beta^*$ does not change the beta function in the arc magnets.

One reason for doing this study is that long term tracking studies with synchrotron oscillations\(^2\) indicate that the dynamic aperture is getting tight at low $\gamma$, $\gamma \simeq 30$. This study indicates that going to even higher $\beta^*$ will not help a great deal.

A table of $A_{SL}$ versus $\beta^*$ is given below

<table>
<thead>
<tr>
<th>$\beta^*$ (m)</th>
<th>$A_{SL}$ (mm)</th>
<th>$\pi A^2_{SL}/\beta$ (mm-mrad)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.25</td>
<td>0.36</td>
</tr>
<tr>
<td>2</td>
<td>7.75</td>
<td>1.20</td>
</tr>
<tr>
<td>6</td>
<td>16.5</td>
<td>5.44</td>
</tr>
<tr>
<td>10</td>
<td>19.5</td>
<td>7.60</td>
</tr>
<tr>
<td>16</td>
<td>20.5</td>
<td>8.40</td>
</tr>
</tbody>
</table>

I wish to thank S. Tepikian and G. Fritz Dell for help in getting the different $\beta^*$ lattices.

References