I. Summary

An improvement plan is now underway which is designed to raise the intensity of the circulating beam in the AGS to $4 \times 10^{13}$ protons. Part of the work involves minimizing losses at transition caused by the negative mass instability. We plan to use pulsed quadrupole doublets to speed up passage through transition. Existing magnets separated by $3/2$ betatron wavelength appear adequate for the purpose. Computer modeling has been carried out, and this work is compared with experimental studies.

II. Introduction

At the present intensity of approximately $1.5 \times 10^{13}$ protons per pulse, AGS beam losses at transition are now less than 5%. However, as improvement plans are implemented and the intensity is increased to $4 \times 10^{13}$ protons per pulse, new mechanisms will become important and the losses will increase. This paper describes our effort directed to minimizing these losses by speeding up passage through transition. It follows the work of Werner Hardt.[1]

III. The $\gamma_t$ Jump

Hardt's idea, which has been implemented at the CERN PS, was based on the observation that quadrupole pairs separated by $1/2$ betatron wavelength and configured as doublets can alter $\gamma_t$ of a synchrotron without affecting its tune. By arranging to cross transition while $\gamma_t$ is rapidly decreasing, the bunch area blow-up caused by the negative mass instability can be substantially reduced. Figure 1 displays the results of Eq. 7.6 of Reference 1, using current AGS parameters. Here the attainable AGS intensity is plotted as a function of bunch area for several crossing speed enhancement factors, $f'$.

IV. Experimental Results and Conclusions

Using the general accelerator design program MAD, [2] we have investigated several sets of quadrupole configurations which fulfill the $1/2$ betatron wavelength separation requirement. We also set as a criterion realizable magnets and deployments (i.e., existing or easily constructed quadrupoles in real AGS straight sections). We soon realized that $3/2$ betatron wavelength separation configurations could also change $\gamma_t$ without substantially affecting the tune.

The most successful arrangement used six existing "slow" quadrupoles, configured as three doublets having $3/2$ betatron wavelength separation: [B17+, D17-], [F17+, H17-], [J17+, L17-], where the locations and polarities are indicated and the magnets comprising doublets are enclosed by brackets. The results of the computer simulation are given in the following table:

<table>
<thead>
<tr>
<th>Quad Strength (K)</th>
<th>0.0</th>
<th>0.2</th>
<th>0.25</th>
<th>0.30</th>
<th>0.35</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_t$ max</td>
<td>22.5</td>
<td>35.8</td>
<td>40.0</td>
<td>44.4</td>
<td>49.0</td>
</tr>
<tr>
<td>$\beta_t$ max</td>
<td>22.3</td>
<td>27.3</td>
<td>28.7</td>
<td>30.0</td>
<td>49.0</td>
</tr>
<tr>
<td>$\Delta\gamma_t$</td>
<td>8.449</td>
<td>9.667</td>
<td>10.366</td>
<td>11.247</td>
<td>12.336</td>
</tr>
<tr>
<td>$\Delta A_{\gamma_t}$</td>
<td>0.0</td>
<td>1.217</td>
<td>1.916</td>
<td>2.297</td>
<td>3.886</td>
</tr>
</tbody>
</table>

A work performed under the auspices of the U.S. Dept. of Energy.

© 1987 IEEE. Personal use of this material is permitted. However, permission to reprint/republish this material for advertising or promotional purposes or for creating new collective works for resale or redistribution to servers or lists, or to reuse any copyrighted component of this work in other works must be obtained from the IEEE.

PAC 1987
goal of $4 \times 10^{13}$ protons, but this can be reached if we take the additional step of using a high frequency rf cavity to double the bunch area before transition.\[4\]

Fig. 2. Quadrupole pulse for altering $\gamma_L$ in relation to the AGS cycle.

V. Acknowledgment

It is a pleasure to thank Werner Hardt for the invaluable help he gave to us during a visit to Brookhaven in the spring of 1986.

References


