BNL-105125-2014-TECH

Booster Technical Note No. 78;BNL-105125-2014-IR

Space charge ?-shifts in the AGS Booster and the need for a vertical injection field bump

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May 1987

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USDOE Office of Science (SC)

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THE NEED FOR A VERTICAL INJECTION FIELD BUMP

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I. INTRODUCTION

Space charge simulation studies indicate that without a vertical injection field bump, the vertical space charge ν-shift may be large, of the order of $\Delta\nu_y = 1$ for $N_b = .5 \times 10^{13}$ protons/bunch. This results from a lack of roundness in the beam. The beam can probably be made round with a vertical injection field bump.

The use of only a horizontal injection field bump results in a flat injected beam, much larger horizontally than vertically. Space charge simulation studies indicate that the growth of the beam due to space charge makes the beam less flat (more round). However, for $N_b = .5 \times 10^{13}$ protons/bunch, the vertical beam size, after growth, is still half of the horizontal beam size which makes the vertical space charge ν-shift about $\Delta\nu_y = 1$.

From the point of view of reducing space charge ν-shifts it seems preferable to make the beam round. Using a vertical injection bump, it seems likely that the space charge ν-shifts would be of the order of $\Delta\nu_x = .5$, $\Delta\nu_y = .5$ for $N_b = .5 \times 10^{13}$ protons/bunch.

II. SPACE CHARGE SIMULATION RESULTS

In computing the space charge ν-shifts, one has to know the dimensions of the beam. The beam dimensions depend on the beam dimensions at injection and on how the beam grows due to space charge.

Assuming that only a horizontal injection field bump is used, then the injected beam is flat. The vertical height of the beam is about ± 8 mm at a QD corresponding to a maximum emittance of 5×10^{-6} M-rad. The horizontal size of the beam can be adjusted using the horizontal field bump. Simulation studies[1] show that there is an optimum size leading to a largest space charge limit. This is shown in Figure 1 where the space charge limit is plotted against the beam half-size XBM. (For more details, see Ref. 1.) The optimum horizontal size is ± 27 mm corresponding to an emittance of 53×10^{-6} M-rad. Because of space charge, the optimum beam will grow from 27 mm x 8 mm to 30 mm x 15 mm when $N_b = .5 \times 10^{13}$ prtons/bunch. Space charge makes the beam more round, but it is still smaller vertically by a factor of 2. The computed space charge ν-shift for the final dimensions of 30 x 15 mm is $\Delta\nu_x = .5$ and $\Delta\nu_y = 1$.

References:

1. G. Parzen, Space Charge Limits in the AGS Booster,to be published IEEE Trans. for the 1987 Particle Accelerator Conference.

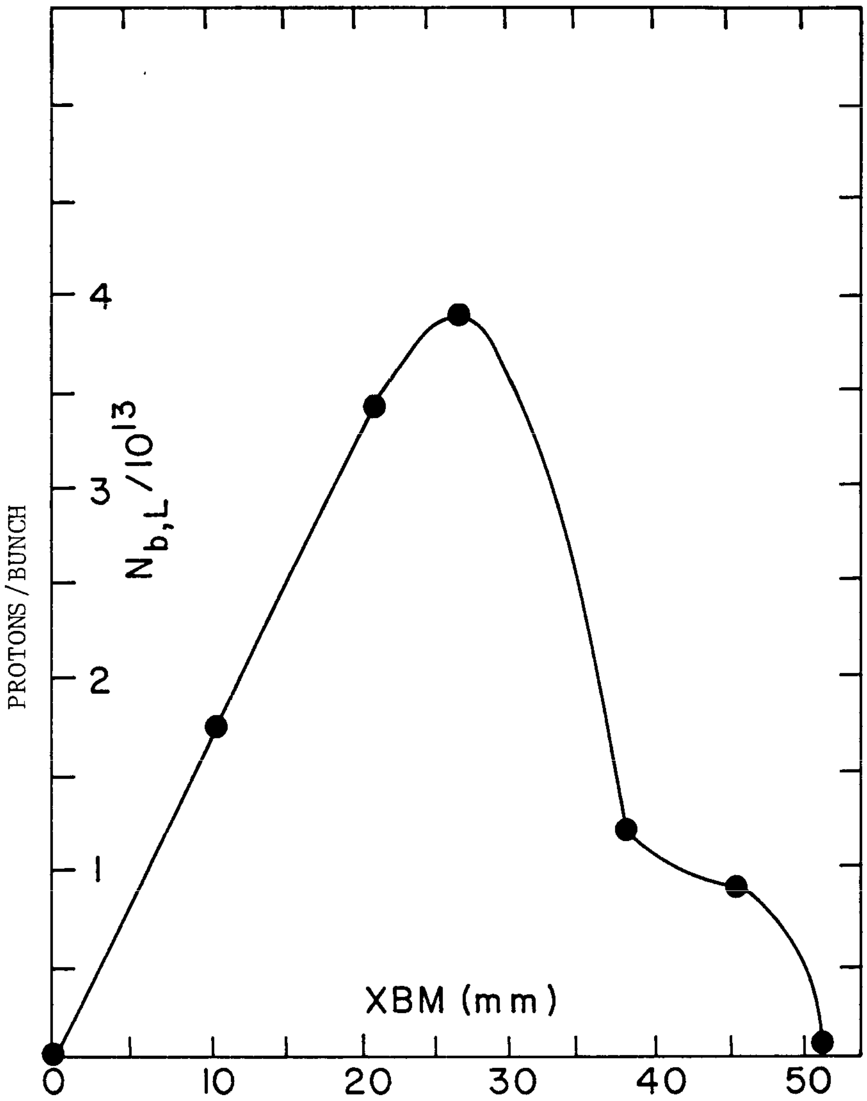

Figure 1