

Beam-Beam Limited Luminosity

H. Hahn

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Collider Accelerator Department
Brookhaven National Laboratory

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BEAM-BEAM LIMITED LUMINOSITY

Assumption and definitions:

$$\alpha = 0$$

$$\epsilon_H = \epsilon_V = \epsilon_N$$

$$\langle \beta \rangle^2 = \beta_H \beta_V$$

$$\sigma_{H,V} = \left(\frac{\epsilon \beta_{H,V}}{6\pi \gamma} \right)^{1/2}$$

$$r = \frac{\sigma_H}{\sigma_V} \quad (0 \leq r \leq 1)$$

Luminosity

$$L = \frac{3}{2} f_o h_B N_B^2 \frac{\gamma - 1}{\epsilon \langle \beta \rangle}$$

with f_o = rotation frequency
 h_B = number of bunches
 N_B = ions/bunch

Tuneshift (RHIC-PG-26)

$$\Delta v_V = 3 r_p \frac{Q^2 N_B}{A \epsilon_N} \frac{1}{1+r}$$

$$\Delta v_H = 3 r_V \frac{Q^2 N_B}{A \epsilon_N} \frac{1}{1+r^{-1}}$$

Luminosity limit: $(\sigma_H \leq \sigma_V)$

$$\frac{L}{\Delta v_V} = \frac{f_o \cdot h_B}{2 \cdot r_p} \cdot \frac{N_B \cdot Y}{\langle \beta \rangle} \cdot (1 + r)$$

RHIC lattice

-- symmetric: $r = \left(\frac{1.44 \text{ m}}{6.50 \text{ m}} \right)^{1/2} = 0.47$

-- asymmetric: $r = 1$

$$\left(\frac{L_{\text{asym}}}{L_{\text{sym}}} \right)_{\text{Beam-Beam}} = 1.36$$