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Beam-Beam Limited Luminosity

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BEAM-BEAM LIMITED LUMINOSITY

Assumption and definitions:

$$\alpha = 0$$

$$\varepsilon_H = \varepsilon_V = \varepsilon_N$$

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

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

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

Luminosity

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

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

Tuneshift (RHIC-PG-26)

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

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

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

$$\frac{L}{\Delta\nu_V} = \frac{f_o\, h_B}{2\, r_p}\, \frac{N_B\, \gamma}{\langle\beta\rangle}\,(1 + r)$$

RHIC lattice

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

- asymmetric $\quad r = 1$

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