

## Beam-Beam Limited Luminosity

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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

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

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

Tuneshift (RHIC-PG-26)

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

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

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

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

RHIC lattice

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

- asymmetric:  $r = 1.00$

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