

scaling of e- threshold density with SPS energy

estimate of threshold density $\rho_{e,thr} \approx \frac{2\gamma Q_s}{\pi\beta_y r_p C} \frac{1}{H}$ ← pinch enhancement

$$H_y \approx 1 + 4 \frac{\sigma_z \omega_{e,y}}{\pi c} = 1 + 4 \sqrt{\frac{N_b r_e \sigma_z \gamma}{\sqrt{2\pi} \beta_y \epsilon_{y,N}}} \approx 4 \sqrt{\frac{N_b r_e \sigma_z \gamma}{\sqrt{2\pi} \beta_y \epsilon_{y,N}}}$$

assume only vertical pinch

second term is much larger

$$\rightarrow \rho_{e,thr} \approx \frac{Q_s}{2\pi r_p C} \sqrt{\frac{\gamma \sqrt{2\pi} \epsilon_{y,N}}{\beta_y \sigma_z N_b r_e}}$$

$$Q_s = \frac{\left(\alpha_c - \frac{1}{\gamma^2}\right) \epsilon_{\parallel,rms}}{2\pi f_{rev} m \gamma \sigma_z^2}$$

synchrotron tune changes if σ_z and ϵ_{\parallel} are held constant

$$\rightarrow \rho_{e,thr} \approx \frac{\left(\alpha_e - \frac{1}{\gamma^2}\right) \epsilon_{\parallel,rms}}{4\pi^2 f_{rev} m \sigma_z^2 r_p C} \sqrt{\frac{\sqrt{2\pi} \epsilon_{y,N}}{\beta_y \sigma_z N_b r_e}} \frac{1}{\sqrt{\gamma}}$$

threshold density increases ~2x for larger energy, strong dependence on bunch length

Incoherent effect of electron cloud at Tevatron?

(Xiaolong Zhang, Oct. 2005, email to Francesco Ruggiero)

Vacuum pressure rises greatly in some of warm sections of Tevatron when the beam intensity exceed certain threshold for a bunch train of only 30 bunches. These phenomena can be explained by the Electron Cloud Effect (ECE). Preliminary simulations for the MI type of elliptical vacuum chamber indicate the ECE will happen for maximum secondary yield of 1.3 and short 2ns bunch length with assumption of 0.5 backscattered very low electrons for the secondary yield curve.

Fast beam emittance growth and short beam lifetime are observed simultaneously with the ECE pressure rise.

But little coherent motion was seen on Schottky monitor.

Lifetime and emittance growth might be explained by **gas scattering**, if the vacuum also strongly degrades in the cold section (where it cannot be measured directly). Alternatively, they could be related to **incoherent effect of electron cloud**.