Electron cloud instability in Super B factories and ILC damping ring

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Threshold of the strong head-tail instability (Balance of growth and Landau damping)

- Stability condition for $\omega_e\sigma_z/c>1$

$$\omega_e = \sqrt{\frac{\lambda_p r_e c^2}{\sigma_y(\sigma_x+\sigma_y)}}$$

$$U = \frac{\sqrt{3}\lambda_p r_0 \beta}{\nu_s \quad \gamma \quad \omega_e\sigma_z/c}\frac{\left|Z_\perp(\omega_e)\right|}{Z_0} = \frac{\sqrt{3}\lambda_p r_0 \beta}{\nu_s \quad \gamma \quad \omega_e\sigma_z/c}\frac{KQ}{4\pi}\frac{\lambda_e}{\lambda_p}\frac{L}{\sigma_y(\sigma_x+\sigma_y)} = 1$$

- Since $\rho_e=\lambda_e/2\pi\sigma_x\sigma_y$,

$$\rho_{e,th} = \frac{2\gamma\nu_s\,\omega_e\sigma_z/c}{\sqrt{3}KQr_0\beta L}$$

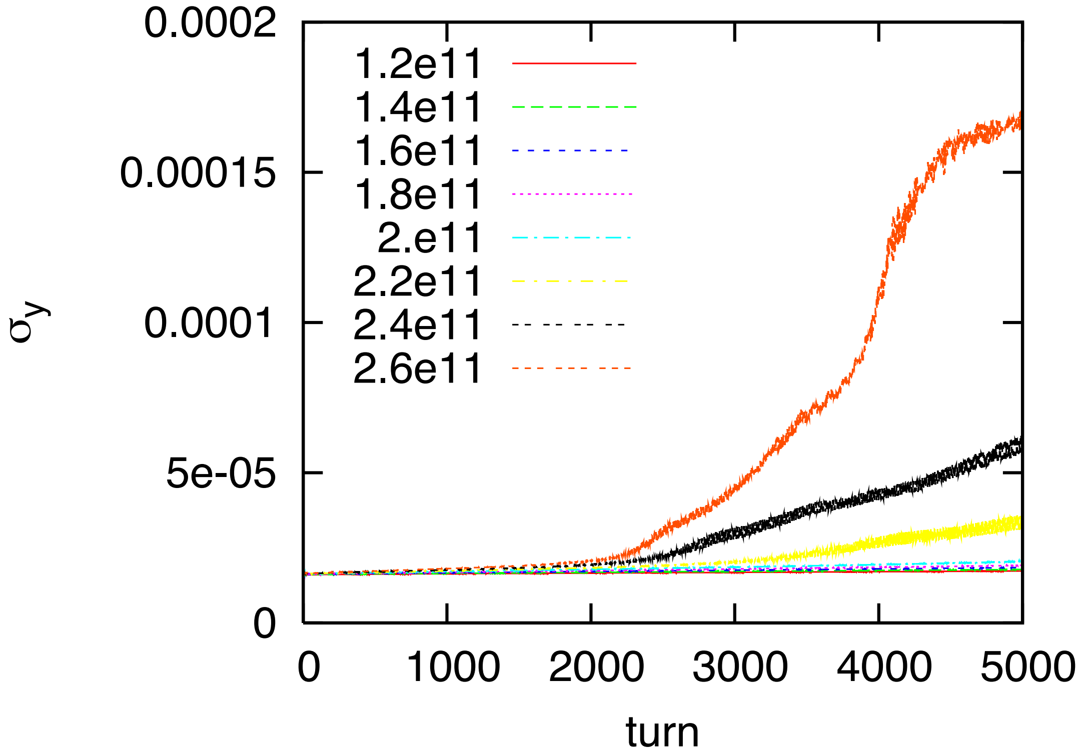
Origin of Landau damping is momentum compaction

$$\nu_s\sigma_z = \alpha\sigma_\delta L$$

- Q=min(Q_{nl}, $\omega_e\sigma_z/c$)
  Q_{nl}=5-10?, depending on the nonlinear interaction.
- K characterizes cloud size effect and pinching.
- $\omega_e\sigma_z/c$~12-15 for damping rings.
- We use K=$\omega_e\sigma_z/c$ and Q_{nl}=7 for analytical estimation.

Threshold of the single bunch instability

- $\rho_{e,th}$=1-2x10^{11} m^{-3} for Super B factories and ILC damping ring.



Cloud density estimation

- The cloud density is measured in each element. The integrated (averaged) density can be suppressed to to $0.5\text{-}2\times10^{11}\ m^{-3}$ (Suetsugu) for Super B factories.

- ILC damping ring is similar as the Super B factories. Operating current of B factories is higher than ILC damping ring.
- If Super B factories work well, ILC damping ring is no problem for electron cloud instability.