Luminosity stabilization at TESLA photon collider

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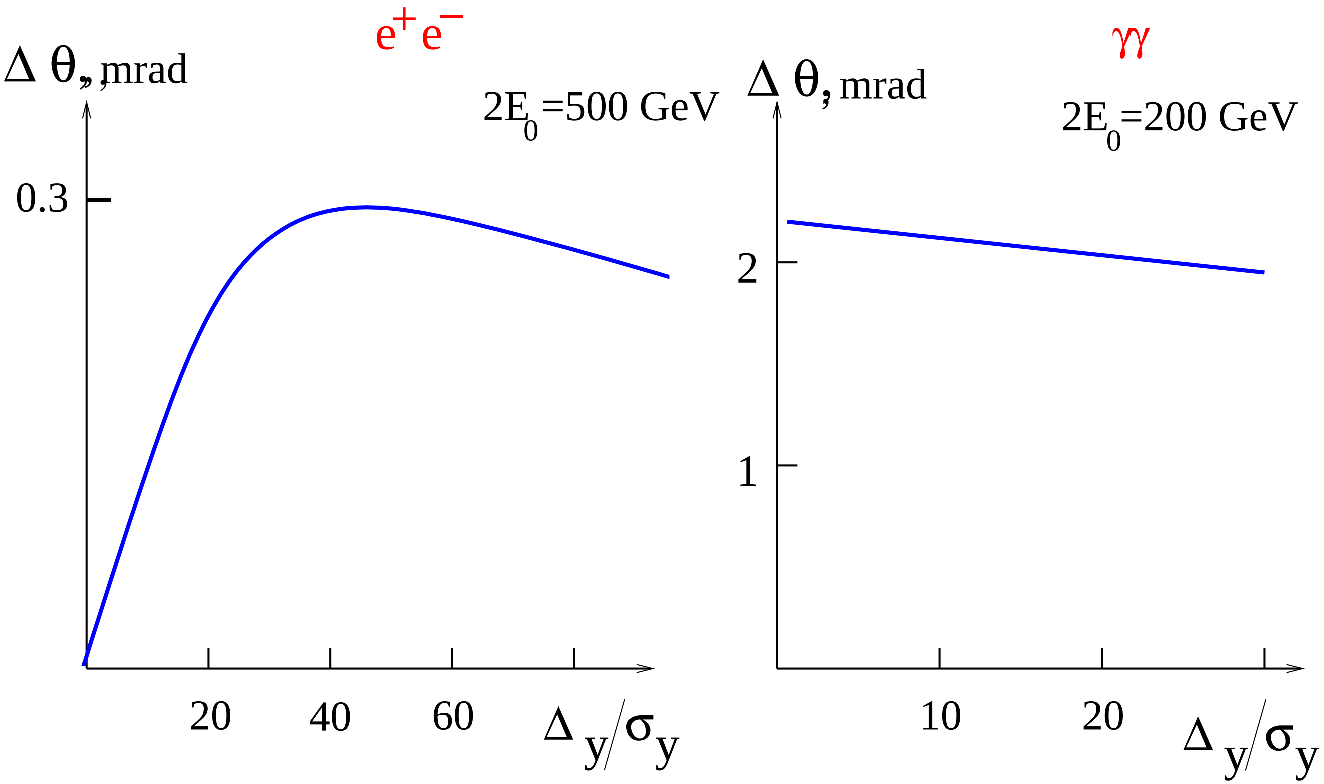
Beam collisions at linear colliders can be controled by the beam beam deflection.

Difference between e^+e^- and $\gamma\gamma$ cases:

1. In the e^+e^- case, at small vertical diplacement the beams attract and oscillate inside each other. In $\gamma\gamma$ case (e^-e^-) as well) the beams repel each other. As result the deflection angle is larger.

2. In $\gamma\gamma$ collisions σ_x is several times smaller than in e^+e^- case ($\sim$ 5 times at TESLA). The kick is much larger then in e^+e^- and almost independent on the initial displacement.



Dependence of the deflection angle on beam parameters

For small deflections, when the vertical beam displacement during the beam collision is less than σ_x

$$\vartheta_y \sim \frac{\sigma_z}{R}; \quad R \sim \frac{pc}{eB}; \quad B \sim \frac{2eN}{\sigma_x \sigma_z}$$

$$\Longrightarrow \vartheta_y \sim \frac{2r_e N}{\sigma_x \gamma},$$

this is valid for $\vartheta_y < \sigma_x/\sigma_z$.

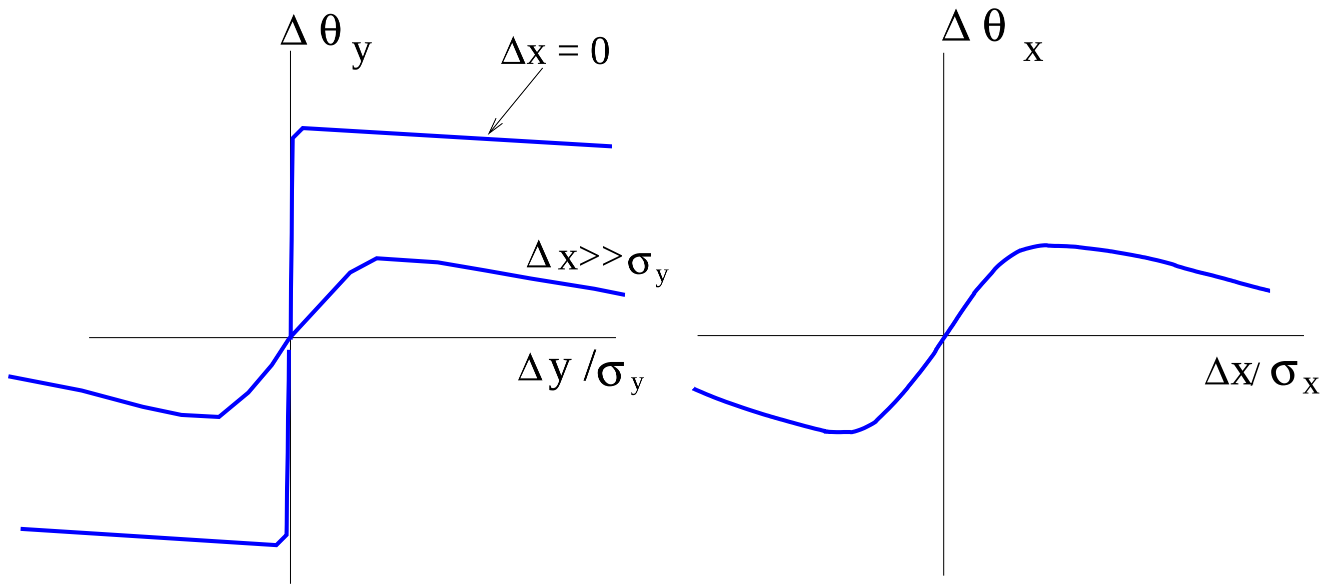
For large deflections (the case for low energy photon colliders, including TESLA $2E = 500$ GeV)

$$\frac{R\vartheta_y^2}{2} \sim 2\sigma_x \Longrightarrow \vartheta_y \sim \sqrt{\frac{4\pi N r_e}{\sigma_z \gamma}},$$

valid for $\vartheta_y > \sigma_x/\sigma_z$. The deflection does not depend on σ_x and σ_y.

At photon colliders about half of particles have $E \sim 0.1{-}0.2E_0$ and essentially influence $\overline{\vartheta_y}$.

$\gamma\gamma$ — the general case



The main difference from e^+e^- is the step-like behavior of the ϑ_y on the displacement Δ_y. This function depends on the conversion efficiency.

Prescription: the feedback system for $\gamma\gamma$ is similar to e^+e^-, but somewhat different algorithm (for the vertical direction). Varing the beam position one should find the jump and continuesly go up and down around this place by small displacements $\Delta_y \ll \sigma_y$. Zero points for the pickups can be found by sending only one beam to the IP.