Is laser wire invasive method?

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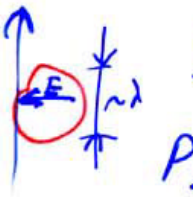

Interaction time $\sim \frac{\lambda}{c}$

$$P_\perp \sim \frac{eE\lambda}{4c}$$

For conversion coeff. $K \sim 10^{-7}$

$$n_\gamma \sigma_c \lambda \sim K \qquad n_\gamma \sim \frac{E^2\lambda}{4\pi\, 2\pi c\hbar}$$

$$\frac{E^2\lambda^2\sigma_c}{8\pi^2\hbar c} \sim K \quad \Rightarrow P_\perp c = e\sqrt{\frac{8\pi^2\hbar c K}{16\,\sigma_c}}$$

$$\sigma_c \sim \pi r_e^2 \qquad P_\perp c \sim mc^2\sqrt{\frac{\hbar c k}{e^2}}$$

Laser wire does not affect the beam at

$$\sqrt{\frac{\varepsilon_n}{\beta\gamma}}\, mc^2\gamma > mc^2\sqrt{\frac{\hbar c k}{e^2}}$$

$$\Rightarrow \frac{\gamma\varepsilon_n}{\beta} > \frac{\hbar c k}{e^2} \qquad \varepsilon_n > \frac{k\beta}{\alpha\gamma} = 137\cdot\frac{k\beta}{\gamma} \quad (1)$$

Example: $K = 10^{-7}$, $\beta = 10$ m, $E = 3$ GeV

$\varepsilon_n > 2\cdot 10^{-8}$ m·rad ($\approx \varepsilon_{ny}$ at LC DR)

Beside, in DR the electron crosses the laser wire many times! $P_{\perp,N} \sim \sqrt{N}\, P_{\perp,1}$

at LC, if β is very large, also may be problems.

Measurement by the laser wire is possible when $z \sim \lambda < \sqrt{\frac{\varepsilon_n \beta}{\gamma}} \Rightarrow \beta > \frac{\lambda^2 \gamma}{\varepsilon_n}$ (2)

Substituting (2) to (1) we get.

$$\varepsilon_n > \lambda \sqrt{137 K}$$ (when increase of emittance is small)

$K = 10^{-7}$, $\lambda \sim 0.5 \cdot 10^{-6}$ m, $\varepsilon_n > 10^{-9}$ m

($\varepsilon_{ny} \sim 3 \cdot 10^{-8}$ cm) OK!

So, the beam size at LL can be measured without increase of emittance, but one should be careful choising the place. If β-function is very large, the electrons which cross the laser wire get deflections larger than their angles in the beam.