Quasi-Real Photon Tagging with JLEIC & Photo-production Rates

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Virtual Photon Flux Factor

$$\frac{d^3\sigma}{d\phi_e dQ^2 dW^2} = \frac{d^3\Gamma}{d\phi_e dQ^2 dW^2}\sigma_\gamma(W^2)$$

$$\frac{d^3\Gamma}{d\phi_e dQ^2 dW^2} \xrightarrow[Q^2 \ll s]{} \frac{\alpha}{2\pi^2}\frac{1}{Q^2}\frac{1}{W^2 - M^2}$$

$$\left[1 - \frac{W^2 - M^2}{s - M^2} + \frac{1}{2}\left(\frac{W^2 - M^2}{s - M^2}\right)^2\right]$$

Near 0° Electron Scattering

- Cannot ignore electron mass

$$Q^2 = 2k \cdot k' - 2m_e^2$$

$$\approx 2|\mathbf{k}||\mathbf{k}'|(1 - \cos\theta_e) + m_e^2 \frac{(|\mathbf{k}| - |\mathbf{k}'|)^2}{|\mathbf{k}||\mathbf{k}'|}$$

- Head-on collisions, and θ_e << *1:*

$$W^2 - M^2 \to (s - M^2)\left[1 - \frac{|\mathbf{k}'|}{|\mathbf{k}|}\right]$$

Integrate the photon flux over azimuth and Q^2, within electron downstream FFQ acceptance

- Define an effective radiation length t^V

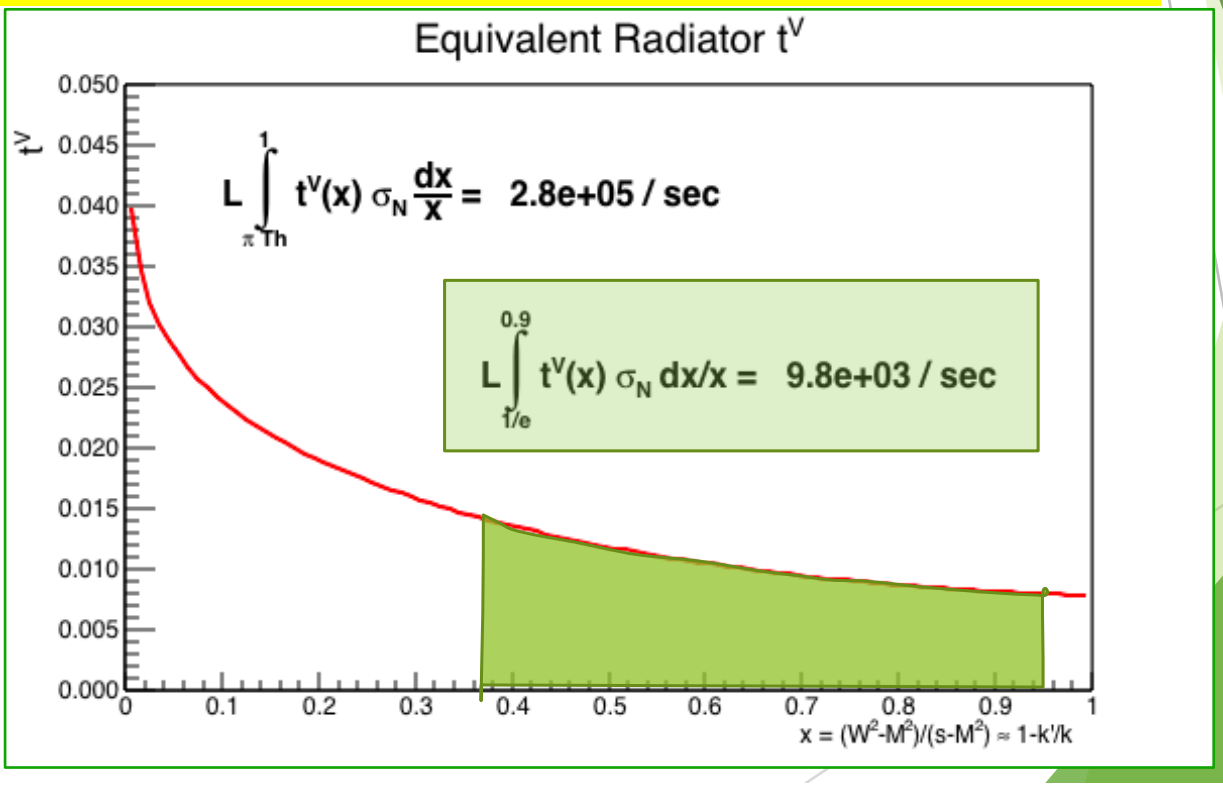
$$\int_0^{2\pi} d\phi_e \int_{Q^2(0^\circ)}^{Q^2_{\mathrm{Max}}} dQ^2 \frac{d^3\Gamma}{d\phi_e dQ^2 dW^2} \equiv \frac{t^V(W^2)}{W^2 - M^2}$$

- Universally: $t^V \approx 0.01$ *to* 0.03

Example: 3 x 100 $(GeV/c)^2$

(Luminosity Maximum $L = 10^{34}/cm^2/s$)

- Effective Radiator, and tagged photo-production rate: $\theta_e \leq 5^\circ$



Bremsstrahlung Singles Rate in tagger

$$\frac{dR}{dW^2} \approx \frac{L_{eN}}{X_0(\text{ion})} \frac{dW^2}{W^2 - M^2}$$

$$R \approx \frac{L_{eN}}{X_0(\text{ion})} \ln \left[\frac{W^2_{\text{Max}} - M^2}{W^2_{\text{Min}} - M^2} \right]$$

- L = 10^4/μb/sec
- X_0(proton) = $7.6 \cdot 10^{-5}$/μb
- Bremsstrahlung Singles Rate for $W^2_{Max}/W^2_{Min} = 1/e$
  - ➔ R = $1.4 \cdot 10^8$/sec < 1/crossing @JLEIC
  - ➔ Tagged photo production fraction ≈ 10^{-4}