Radiative Corrections for Impact Studies

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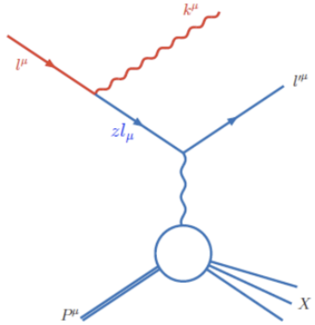
Radiative corrections – collinear approximation

- Radiative corrections can have a significant impact on the interpretation of experimental data
- Collinear approximation: Neglect the transverse component of the 4-momenta of the emitted photon



Radiative corrections in DIS

Initial and final state radiative corrections [Kripfganz, Möhring, Spiesberger, Z.Phys.C 49 (1991)]

$$\frac{d^2\sigma}{dxdy} = \int_0^1 \frac{dz_1}{z_1} D_{e/e}(z_1) \int_0^1 \frac{dz_3}{z_3^2} \bar{D}_{e/e}(z_3) \frac{y}{\hat{y}} \frac{d\hat{\sigma}_{\text{Born}}}{d\hat{x}d\hat{y}}$$

$$\frac{d^2\sigma}{dxdQ^2} = \int_0^1 dz_1 z_1 D_{e/e}(z_1) \int_0^1 \frac{dz_3}{z_3^2} \bar{D}_{e/e}(z_3) \frac{y}{\hat{y}} \frac{d\hat{\sigma}_{\text{Born}}}{d\hat{x}d\hat{Q}^2}$$

$$D_{e/e}(z) = \bar{D}_{e/e}(z) = \left[\delta(1-z)\left[1+\frac{\alpha}{2\pi}L\left(2ln\,\epsilon+\frac{3}{2}\right)\right]+\theta(1-\epsilon-z)\frac{\alpha}{2\pi}L\frac{1+z^2}{1-z}\right]$$

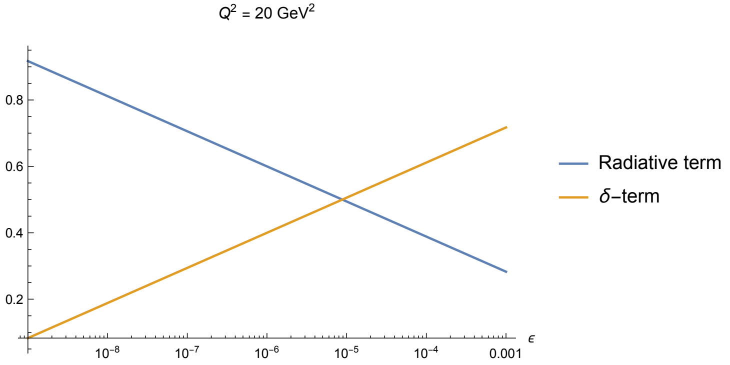
where $L = ln\frac{Q^2}{m_e^2}$

$$\hat{x} = \frac{z_1 xy}{z_1 z_3 + y - 1}, \qquad \hat{y} = \frac{z_1 z_3 + y - 1}{z_1 z_3}, \qquad \hat{Q}^2 = \frac{z_1}{z_3} Q^2$$

$$z_1^{\text{min}} = \frac{1-y}{1-xy}, \qquad z_3^{\text{min}} = 1 - y(1-x)$$

Radiative corrections in DIS

$$\int_0^1 dz \left[\delta(1-z)\left[1 + \frac{\alpha}{2\pi} L \left(2 ln\, \epsilon + \frac{3}{2} \right)\right] + \theta(1-\epsilon-z)\frac{\alpha}{2\pi} L \frac{1+z^2}{1-z} \right]$$



Radiative corrections in DVCS

Initial and final state radiative corrections

$$\frac{d^5\sigma}{dx dQ^2 dt d\phi d\phi_S} = \int_0^1 dz_1 z_1 D_{e/e}(z_1) \int_0^1 \frac{dz_3}{z_3^2} \bar{D}_{e/e}(z_3) \frac{y}{\hat{y}} \frac{d^5\hat{\sigma}_{\text{Born}}}{d\hat{x} d\hat{Q}^2 dt d\phi d\phi_S}$$

Define new variables: $z_1 = 1 - 10^{z_1'}$, $\quad z_3 = 1 - 10^{z_3'}$, $\quad z_1', z_3' \in [-8, 0]$

$$\frac{d^5\sigma}{dx dQ^2 dt d\phi d\phi_S} = \int_{-8}^{0} dz_1' \, (1 - z_1) \, z_1 \, ln(10) \, D_{e/e}(z_1)$$

$$\int_{-8}^{0} dz_3' \, \frac{1 - z_3}{z_3^2} \, ln(10) \, \bar{D}_{e/e}(z_3) \frac{y}{\hat{y}} \frac{d^5\hat{\sigma}_{\text{Born}}}{d\hat{x} d\hat{Q}^2 dt d\phi d\phi_S}$$

$$\hat{x} = \frac{z_1 x y}{z_1 z_3 + y - 1}, \qquad \hat{y} = \frac{z_1 z_3 + y - 1}{z_1 z_3}, \qquad \hat{Q}^2 = \frac{z_1}{z_3} Q^2$$

$$z_1^{\text{min}} = \frac{1 - y}{1 - xy}, \qquad z_3^{\text{min}} = 1 - y(1 - x)$$

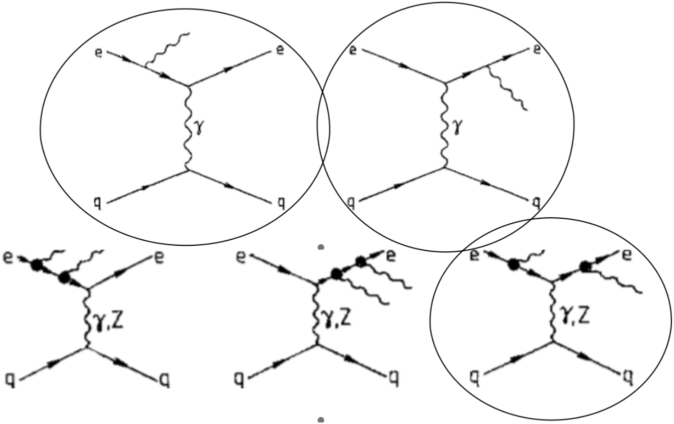
Kinematics

Kinematics used in the samples:

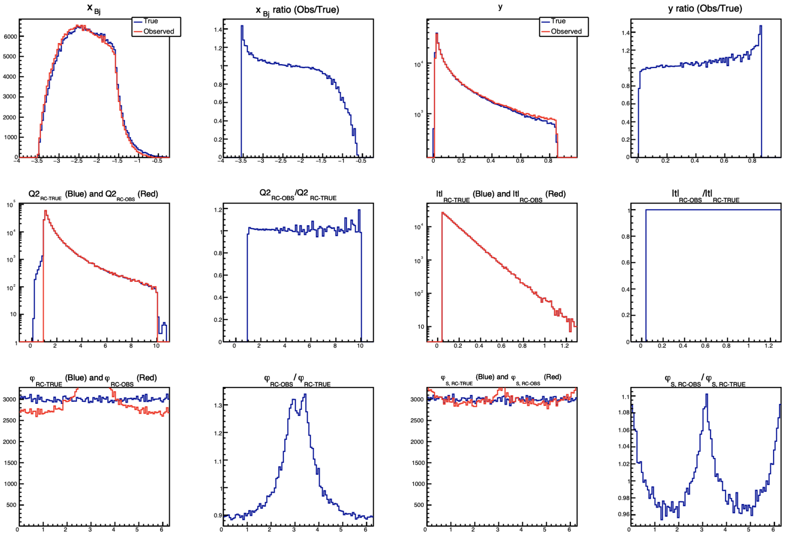
- pure DVCS, 10×100 GeV, $\epsilon = 10^{-2}$
- $0.0001 < x_{\mathrm{Bj}} < 0.630957$
- $0.04 < |t| < 1.3 GeV^2$
- $1.0 < Q^2 < 10.0 GeV^2$
- $0.0 < \phi < 2\pi$
- $0.0 < \phi_S < 2\pi$
- $0.01 < y < 0.85$

Radiative corrections – first set

- Contributions from the following graphs:

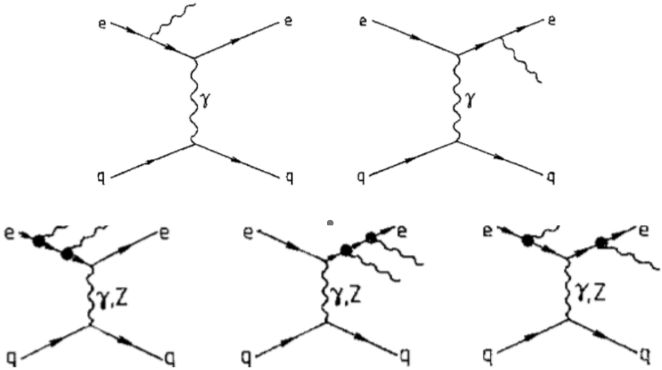


Radiative corrections – first set of kinematics



Radiative corrections – second set

- Contributions from the following graphs:



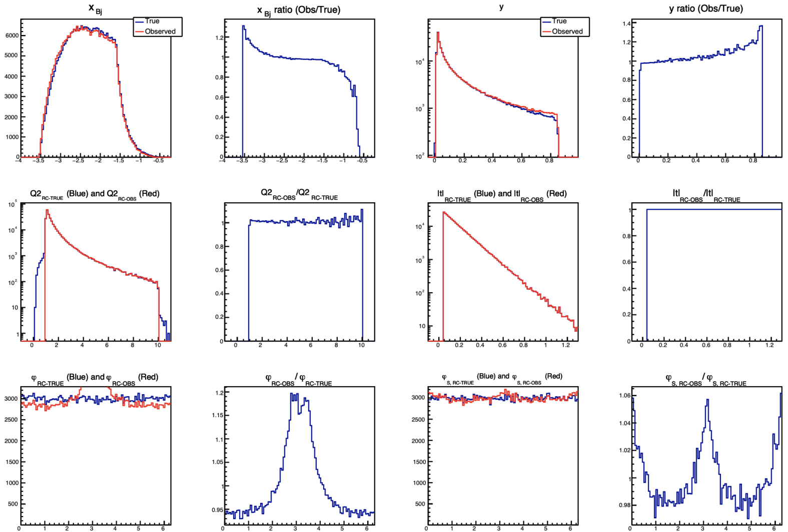
- Expression for $2 \times ISR$ [Kripfganz, Möhring, Spiesberger, Z.Phys.C 49 (1991)]

$$\left.\frac{d^2\sigma}{dx\,dy}\right|_i^{(2)} = \frac{1}{2}\left(\frac{\alpha}{2\pi}\right)^2 L_e^2 \cdot \left\{ \int_{z_1^{\min}}^{1} dz_1 \left[2\frac{1+z_1^2}{1-z_1}\left(2\ln(1-z_1) - \ln(z_1) + \frac{3}{2}\right) \cdot (\sigma_0(z_1,1) - \sigma_0(1,1)) + ((1+z_1)\ln z_1 - 2(1-z_1))\sigma_0(z_1,1) \right] + \left\{ [S(z_1^{\min})]^2 + 4\mathrm{Li}_2(1-z_1^{\min}) + z_1^{\min}(z_1^{\min}-2)\ln z_1^{\min} - \frac{1}{4}(z_1^{\min})^4 - (z_1^{\min})^3 - (z_1^{\min})^2 - z_1^{\min} + \frac{13}{4} \right\} \sigma_0(1,1) \right\}. \quad (31)$$

- The corresponding radiator function:

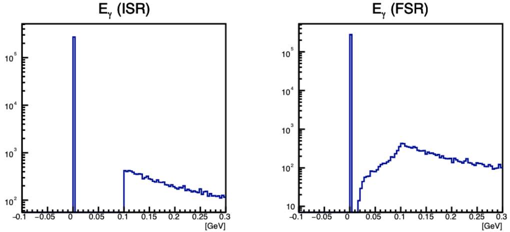
$$D_{e/e}^{(2)}(z) = \delta(1-z)\left(\frac{\alpha}{2\pi}\right)^2 \frac{L_e^2}{2}\left[\frac{13}{4} + 6\ln\epsilon + 4\ln^2\epsilon + 2\,z_{\min}^2 \ln(z_{\min}) - z_{\min}^2\right] + \Theta(1-\epsilon-z)\left(\frac{\alpha}{2\pi}\right)^2 \frac{L_e^2}{2}\left[2\frac{1+z^2}{1-z}\left(2\ln(1-z) - \ln(z) + \frac{3}{2}\right) + (1+z)\ln(z) - 2(1-z)\right]$$

Radiative corrections – second set kinematics

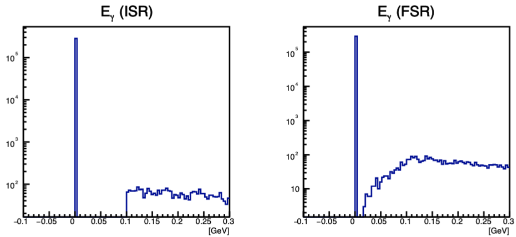


Radiative corrections – energy of radiated photons

- Energy of radiated photons in the first set:



- Energy of radiated photons in the second set:



Summary

- The effects of RCs on the kinematic variables have been assessed
- First-order contributions as well as three of the second-order diagrams have been implemented