Luminosity measurement at the EIC

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Luminosity measurement at the EIC

From RHIC to the Electron-Ion Collider (EIC)



- Very first polarized electron ion/proton collider
- Concept for the EIC is described in arXiv:2103.05419
- CM energy from 29 to 141 GeV
- Luminosity up to 10^{34} cm⁻² s⁻¹
- Ion/proton beam from existing RHIC collider
- Physics includes spin structure, parton distributions and gluon saturation

Precise luminosity determination is critical for most of the physics program

Luminosity measurement by bremsstrahlung photons

Large cross section driven by QED, photons in a narrow angular cone along electron beam

$$\frac{d\sigma}{dE_{\gamma}} = 4\alpha r_e^2 \frac{E'_e}{E_{\gamma} E_e} \left(\frac{E_e}{E'_e} + \frac{E'_e}{E_e} - \frac{2}{3}\right) \left(\ln \frac{4E_p E_e E'_e}{m_p m_e E_{\gamma}} - \frac{1}{2}\right); \qquad \frac{d\sigma}{d\theta_{\gamma}} \sim \frac{\theta_{\gamma}}{\left((m_e/E_e)^2 + \theta_{\gamma}^2\right)^2}$$



section, effect of beam angular divergence is illustrated

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- Desired precision is 1%
- Very large cross section in e-Au case
- Angular distribution is modified by beam angular divergence

for several electron and proton/ion beam energies Jaroslav Adam (BNL)

Mechanism for luminosity measurement



- Two methods to detect the bremsstrahlung photons
- Non-converted photons are detected at PCAL
- Spectrometer SPEC detects converted e⁺e⁻ pairs
- Geant4 provides basic characteristics like spectrometer acceptance

Figure: Geant4 model for luminosity monitor

Collimator

Exit winitow



Figure: Spectrometer acceptance as a function of photon energy

Challenging goal of 1% precision will require to cope with high event rates and beam effects