MOLLERsim Event Generators

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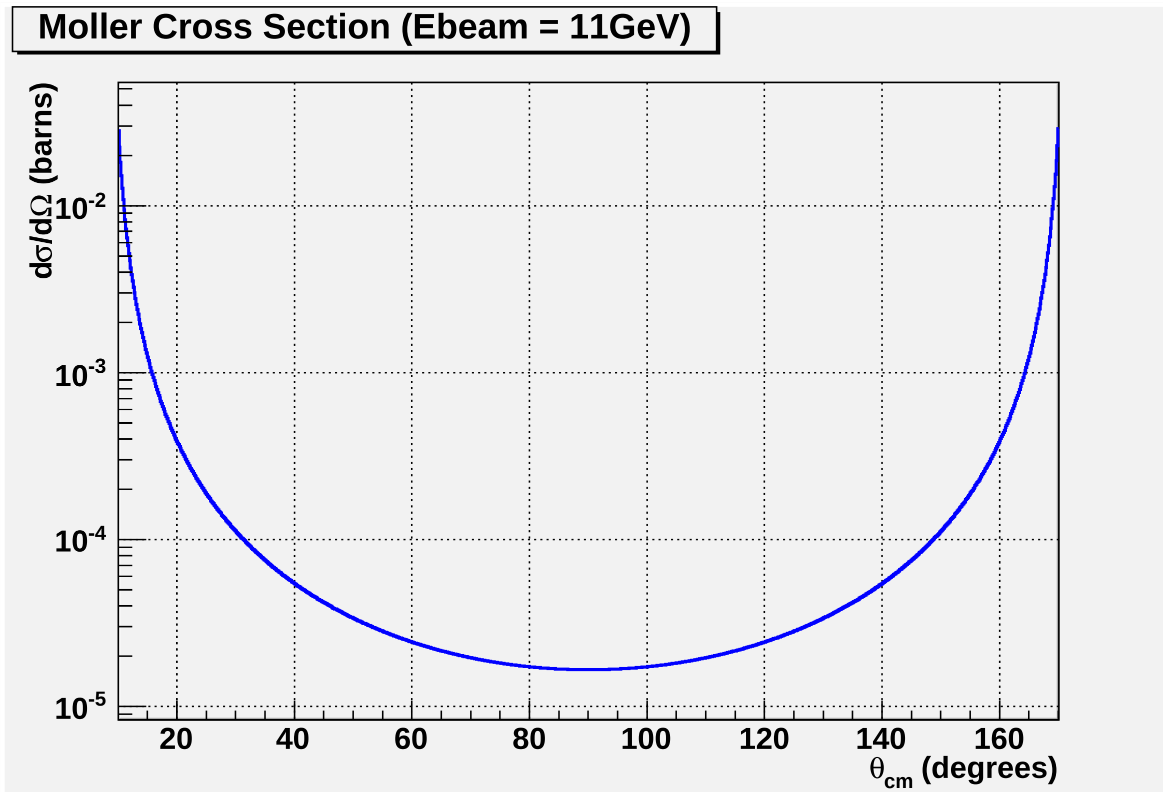
Outline

- Overview: Physics Generators
  - Møller
  - Elastic ep
  - Inelastic ep
- Radiative Effects and Other Details
- What's still needed

Møller Event Generator



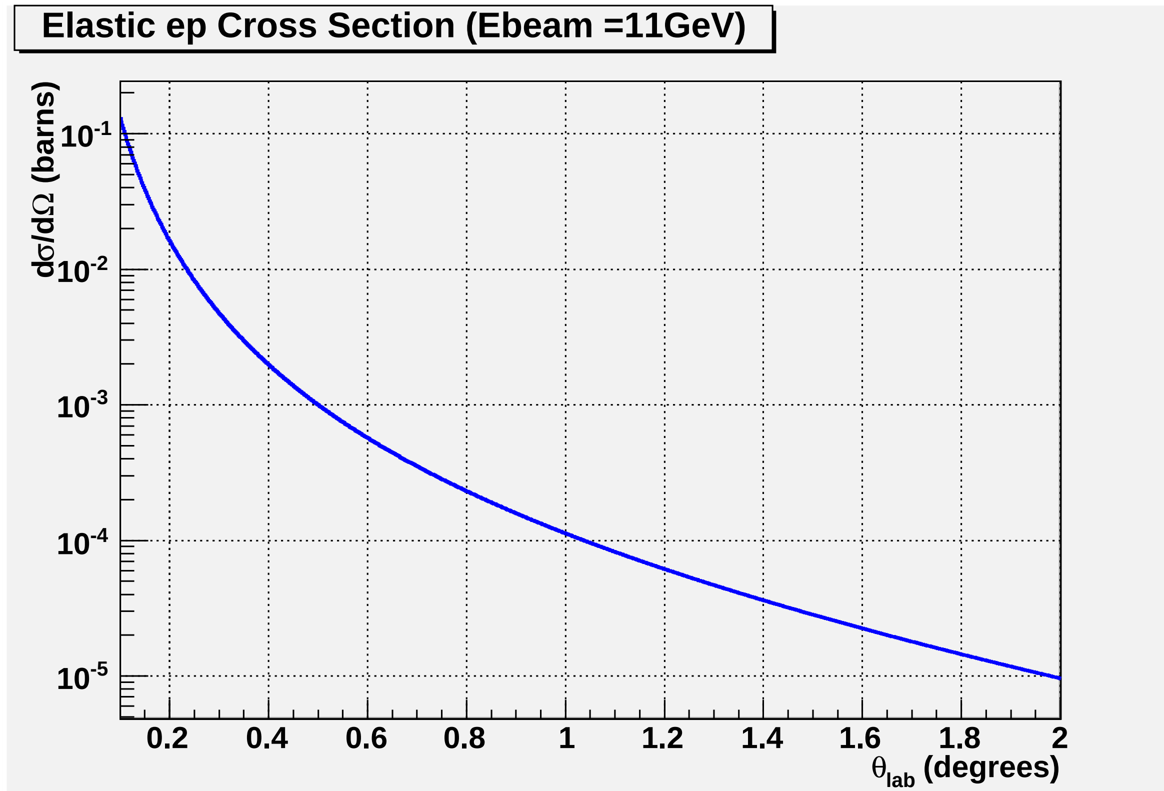
$$\frac{d\sigma}{d\Omega^{cm}} = \frac{4\alpha^2}{s}\left[\frac{\zeta}{\sin^4\theta_{cm}} + \frac{(1-\frac{3}{4}\zeta)}{\sin^2\theta_{cm}} + \frac{1}{4}\right] \tag{1}$$

$$\text{where} \quad \zeta = \frac{(2\xi-1)^2}{(\xi-1)^2}, \quad \xi = \frac{s}{4m^2}, \quad s = 2m^2 + 2mE^{lab}_{vertex} \tag{2}$$

Møller Event Generator: Coding Stradegy

- Generate differential cross section (XS) table as function of θ_{cm}
- Integrate XS and redefine table as running integral sum normalized to total XS. Now table values run from [0,1] as function of θ_{cm}
- To choose θ_{cm} for each thrown event: Pick random number (r1) between [0,1], find the two table indices closest to condition r1 = normXS, and then do linear interpolation between the indices to get the precise angle. This gives proper angular distribution
- To choose ϕ_{cm} for each event: Uniformly sample between $[0,2\pi]$
- Calculate kinematics in CM and then transform to the lab frame

Elastic ep Event Generator



$$\frac{d\sigma}{d\Omega} = \frac{\alpha^2}{4{P_0}^2 \sin^4(\frac{\theta}{2})} \frac{\cos^2(\frac{\theta}{2})}{1+2\frac{P_0}{m_p}\sin^2(\frac{\theta}{2})} \left[\frac{G_{Ep}^2 + \tau G_{Mp}^2}{1+\tau} + \frac{\tau^2 G_{Mp}^2 \sin^2(\frac{\theta}{2})}{\cos^2(\frac{\theta}{2})} \right] \quad (3)$$

$$\text{where} \quad \tau = \frac{Q^2}{4{m_p}^2}, \quad G_{Ep} = \frac{1}{(1+\frac{Q^2}{0.71})^2}, \quad G_{Mp} = \mu_p G_{Ep} \quad (4)$$

Inelastic ep Event Generator (from P.Bosted)

$$\frac{d\sigma}{d\Omega dE'} = \frac{5.2\times 10^{-9}}{(E\sin^2(\frac{\theta}{2}))^2}\left[\frac{\cos^2(\frac{\theta}{2})F_2}{\nu} + \frac{2\sin^2(\frac{\theta}{2})F_1}{m_p}\right] \tag{5}$$

$$F_1 = (\nu - \frac{Q^2}{2m_p})\frac{m_p\sigma_T}{4\pi^2\alpha(0.389)}, \tag{6}$$

$$F_2 = \frac{F_1}{(1+\frac{2(m_p x)^2}{Q^2})2x(1+Q^2)}, \tag{7}$$

$$Q^2 = 4EE'\sin^2(\frac{\theta}{2}), \quad x = \frac{Q^2}{2m_p(E-E')}, \quad \nu = \frac{Q^2}{2m_p x} \tag{8}$$

$$\sigma_T \equiv \text{total photoabsorption cross section (use table from PB)} \tag{9}$$

$$W^2 = {m_p}^2 + 2m_p(E-E') - Q^2 \tag{10}$$

Inelastic ep Event Generator: Coding Stradegy

- Generate angular distribution in same fashion as for Møller and elastic ep–using event-by-event generated normalized XS table...
- Since we have double differential XS, we must also sample the event inelasticity (E - E'), where $E = E_{vertex}$
- Choose upper E' sampling limit such that $W = m_p + m_\pi = 1.0779$ and $Q^2 = 0 \longrightarrow E'_{max} = \text{Evertex} - 0.150$
- Choose lower E' sampling limit such that $W = 4.5 \longrightarrow E'_{min} = \text{Evertex} - 10.3219$

Radiative Effects

- Radiative correction algorithm taken from genercone
- Only incoming (pre-vertex) bremsstrahlung handled; outgoing effects taken care of entirely by GEANT

Beam Effects

- Uniformly rastered beam 5 x 5 mm^2, centered on the target cell

Other Details

- z-target vertex uniformly sampled; realistic vertex distribution obtained by cross section weighting events

What's still needed

- Aluminum Target window scattering
- Realistic beam angle and offset at the target
- Realistic target z-vertex sampling
- Multiple scattering for incoming (pre-vertex) beam
- Internal radiative vertex correction
- Beam - target - spectrometer misalignments