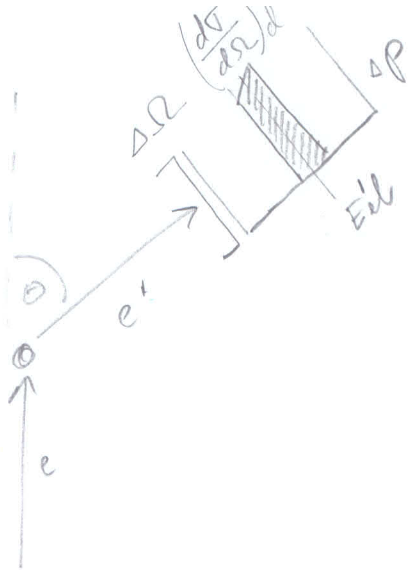
21.2.15

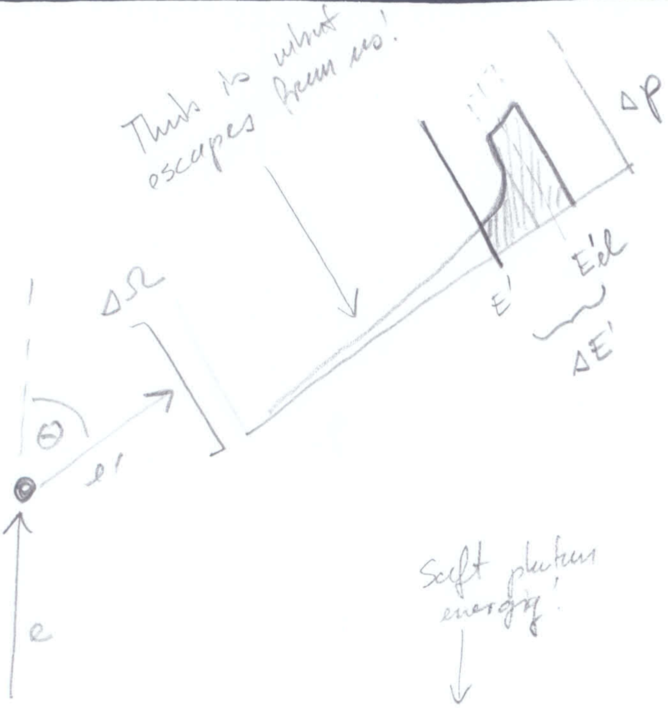
Elastic Scattering:



$\left(\frac{d\sigma}{d\Omega}\right)_{el}$ ≡ has no extra momentum dependence

E'_{el} ≡ Energy of the elastically scattered electron!

Radiative correction for the El. Scattering:



E' ≡ (Maximum) is the lower limit of the momentum acceptance (Vanderhaeghen) the energy of the detected electron!

Since Elastic c.s. has no explicit dependence on E' The Maximum interpretation makes more sense. The Momentum acceptance is needed simply to get electrons in. $\Delta E'$ means zero momentum acceptance, which correctly results in zero CS!

Soft photon energy!

$$\left(\frac{d\sigma}{d\Omega}\right)_{\gamma\text{-soft}} = \left(\frac{d\sigma}{d\Omega}\right)\cdot e^{\delta_R(\Delta E')}$$

For: $E = 700\ \mathrm{MeV}$, $\theta = 141^\circ$, $Q^2 = 0.2\ \left(\frac{GeV}{c}\right)^2$

$\Delta E' = 0.01\ E'_{el} \Rightarrow \delta_R = -4.5\%$

$e^{\delta_R} = 0.956 \Rightarrow$ We loose 4% of the CS, which escapes to the undetected part of the tail!

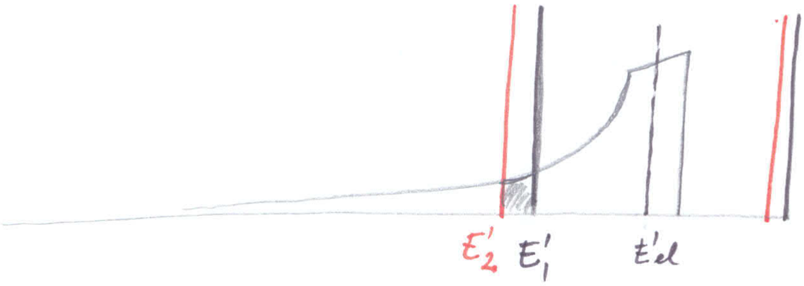
$$e^{\delta_R} = \left(\frac{\eta^2 \Delta E_{el}'^2}{E\, E'} \right)^a \quad ; \quad a = \frac{\alpha}{\pi}\left[\ln\left(\frac{Q^2}{m^2}\right) - 1 \right]$$

$$\eta = \frac{E}{E''_{el}} \quad ; \quad \Delta E' \ll E' \;\Rightarrow\; E' \approx E'_{el}$$

$$e^{\delta_R} = \left(\eta \cdot \frac{\cancel{E} \quad \Delta E_{el}'^2}{E'_{el} \cdot \cancel{E}\; E'} \right)^a = \eta^a \cdot \left(\frac{\Delta E'}{E'_{el}} \right)^{2a}$$

This is fixed with E, ϑ

Measuring in a single momentum bin:



$a_1 \approx a_2 = a$

$\Delta E_2' = \Delta E'$, $\Delta E_1' = \Delta E' - d\Delta E'$

$$\left(\frac{d\sigma}{d\Omega}\right)_{\gamma 2} - \left(\frac{d\sigma}{d\Omega}\right)_{\gamma 1} = \left(\frac{d\sigma}{d\Omega}\right)_{el} \cdot \left[\eta^{a_2} \left(\frac{\Delta E_2'}{E'_{el}} \right)^{2a_2} - \eta^{a_1} \left(\frac{\Delta E_1'}{E'_{el}} \right)^{2a_1} \right]$$

$$= \left(\frac{d\sigma}{d\Omega}\right)_{el} \eta^a \left(\frac{\Delta E'}{E'_{el}} \right)^{2a} \cdot \left[1 - \left(\frac{(\Delta E' - d\Delta E)\cancel{E'_{el}}}{\Delta E' \cancel{E'_{el}}} \right)^{2a} \right] \approx$$

$$\approx \left(\frac{d\sigma}{d\Omega}\right)_{el} \eta^a \left(\frac{\Delta E'}{E'_{el}} \right)^{2a} \cdot \left[1 - \left(1 - 2a \cdot \frac{d\Delta E'}{\Delta E'} \right) \right]$$

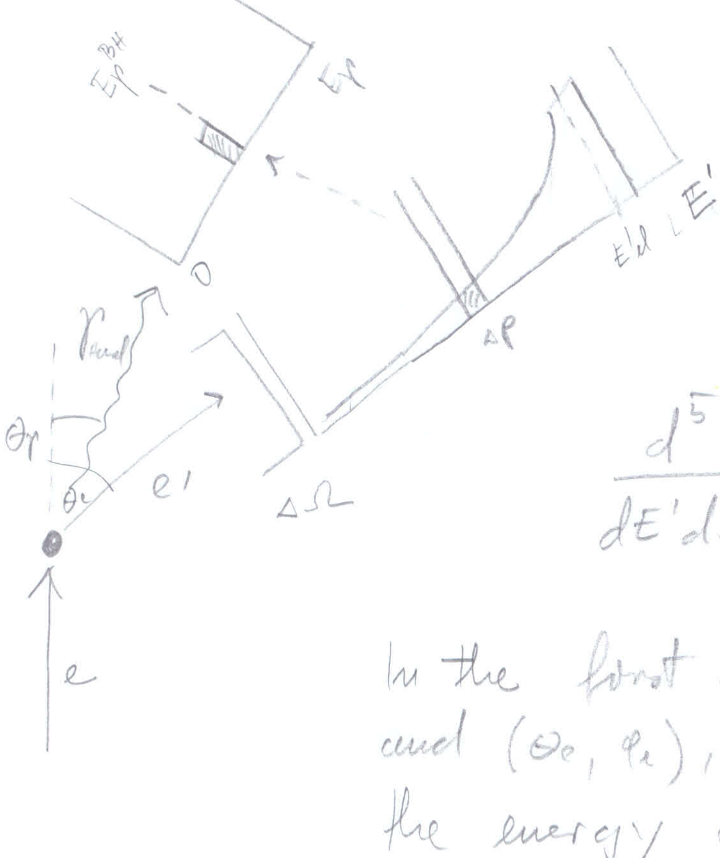
$$= \left(\frac{d\sigma}{d\Omega}\right)_{el} \eta^a \left(\frac{\Delta E'}{E'_{el}} \right)^{2a} \cdot \frac{2a}{\Delta E'} \cdot d\Delta E'$$

$$\frac{d^3\sigma}{d\Delta E'\, d\Omega} = \underbrace{\left(\frac{d\sigma}{d\Omega}\right)_{el} \cdot \frac{2a}{\Delta E'}}_{(*)} \cdot y^{a} \cdot \left(\frac{\Delta E'}{E'_{el}}\right)$$

This is our first approximation for the B-H cross section, which has additional degree of freedom! After calculating the true cross section we divide (*) out. What remains, we use as <u>effective correction to the CS</u> of the next order!

The same formula we would obtain, if we would calculate simple derivation of the el. CS.

Bethe - Heitler processes (only):

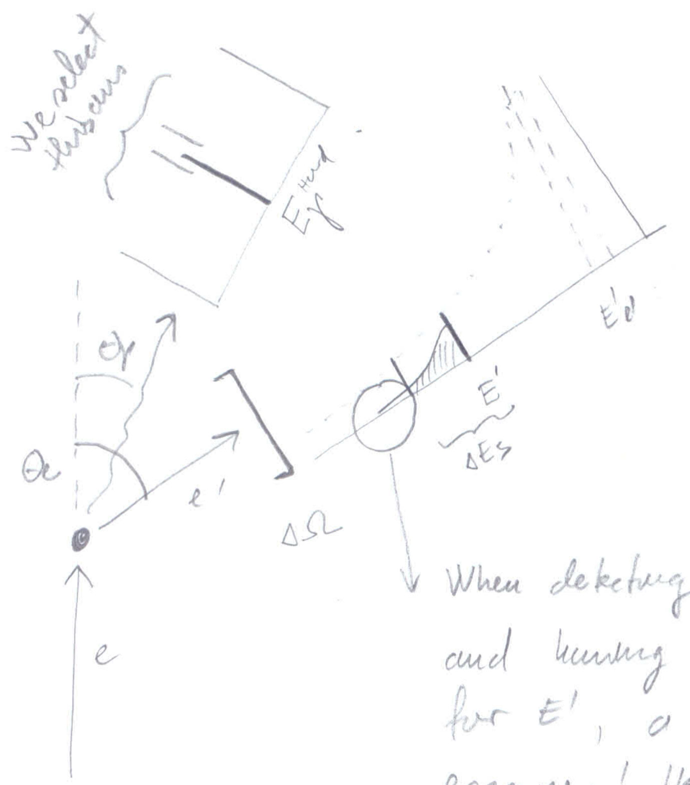


$$\boxed{\Delta E' = E'_{el} - E'}$$

$$\frac{d^5\sigma}{dE'\, d\Omega_e\, d\Omega_\gamma}$$

In the first order, knowing the E' and (Θ_e, φ_e), $(\Theta_\gamma, \varphi_\gamma)$ also defines the energy of the hard-photon!

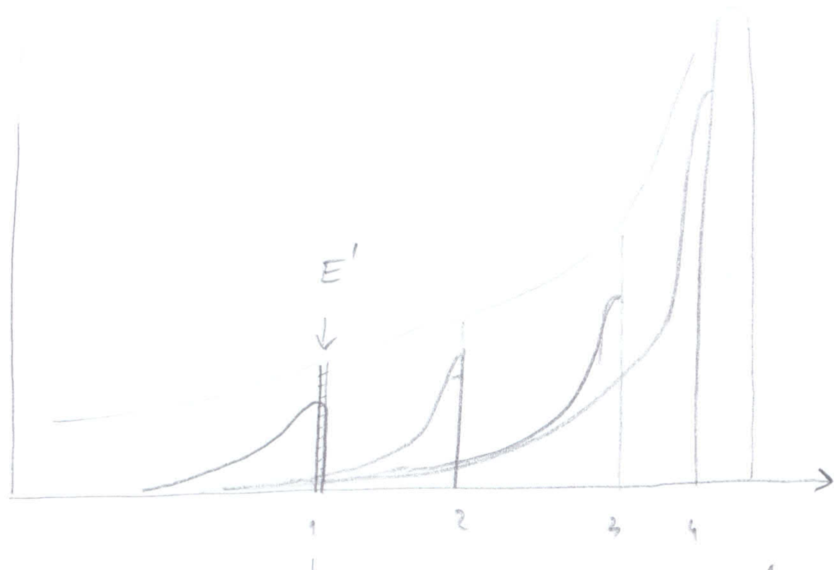
Bethe - Heitler + Soft Photon:



When detecting photon with E_γ^{Hard} and having limited acceptance for E', a part of the CS escapes! Hence, we see less events!

$$\left(\frac{d^5\sigma}{dE' d\Omega_e d\Omega_\gamma}\right)_{soft} = \left(\frac{d^5\sigma}{dE' d\Omega_e d\Omega_\gamma}\right)_{BH} \cdot e^{\delta_R(\Delta E_s)}$$

We do not detect Hard photon. Hence, all the photons need to be considered for a given E' bin!



To see all events in this bin, we need to integrate the distributions from this bin to E' elastic.

$$\frac{d^6\sigma}{d\Delta E_s\, dE'\, d\Omega_e\, d\Omega_g} = \underbrace{\frac{d^5\sigma\,(E'_{BH})}{dE'\, d\Omega_e\, d\Omega_g}}_{d^5\sigma_{BH}}\; I\,(E'_{BH}, \Delta E_s)$$

when only BH process!

When using elastic approximation:

$$\frac{d^6\sigma}{d\Delta E_s\, dE'\, d\Omega_e\, d\Omega_g} = d^5\sigma_{BH}\cdot\frac{t}{\Delta E_s}\cdot\left(\frac{\Delta E_s}{E'_{BH}}\right)^t$$

This is still dilema, what comes here!

$$d^5\sigma_{Full}(E') = \int_{E'}^{E'_{el}} dE'_{BH}\; d^5\sigma_{BH}(E'_{BH})\cdot\frac{t}{E'_{BH}-E'}\cdot\underbrace{\left(\frac{E'_{BH}-E'}{E'_{BH}}\right)^t}_{e^{\delta}}$$

This integration is done by MC-simulation!

This is corrected CS for a particular bin!

$$\boxed{E'_{BH} \approx E'}$$

$\Delta E' = E'_{BH} - E'$

$d\Delta E' = dE'_{BH}$

Assuming, that $d^5\sigma_{BH}(E'_{BH}) \approx d^5\sigma_{BH}(E')$

$$d^5\sigma_{Full}(E') = d^5\sigma_{BH}(E')\cdot\int_0^{E'_{el}-E'} d\Delta E'\cdot\frac{t}{\Delta E'}\left(\frac{\Delta E'}{E'}\right)^t$$

$$= d^5\sigma_{BH}(E')\cdot\left(\frac{E'_{el}-E'}{E'}\right)^t$$

I believe, we can make this approximation, because contribution to the integral, when away from $E'_{BH} \neq E'$ is small.

What we have in the Simul ++ is

$$d^5\sigma_{Full}(E') = d^5\sigma_{BH}(E')\cdot\left(\frac{E'_{el}-E'}{E'_{el}}\right)^{t} \qquad (*)$$

Is this OK?

Using that factor introduces numerical instabilities when in the vicinity of $E'_{el}-E' \to 0$, since our smallest difference is 10^{-10}.

My standalone simulation:

Here I want to compare what we have in (*) with the elastic and full calculations

$$d^5\sigma_{Full}(E') = \int_{E'}^{E'_{el}} dE'_{BH}\, d^5\sigma_{BH}(E'_{BH}) \underbrace{\frac{t}{E'_{BH}-E'}}_{\boxed{*}} e^{\delta_{El}}$$

I did this by replacing $e^{\delta_{El}}$ with the $e^{\delta_{Full}}$.

Here I considered, that $e^{\delta_{El}} \neq f(E'_{el}, E')$ but rather $f(E'_{BH}, E')$. Then its contribution much smaller. However, with such comparison the majority of elastic approx remains inside via $\boxed{*}$. What shall we do about that!?

With this approximation we see, that difference between Elastic and Full correction is ~ 1%.
This test was motivated to get an ⟨effective⟩ correction like (*), using approximation that events are elastically $\left(\frac{1}{\Delta E}\right)$ distributed!

Question:

The (*) is not the best one. I tried to remove this correction and replaced it with the Simul's internal radiative corrections. The results are not as good! Furthermore, I added a random event generator, that in peaking approx. generates the loss of soft 'utan'! This also does not work as good as expected!

Question #2:

Without the cut on RodCorr we see to many events in the peak. This could also be an indication that we do not pull enough events into the tail. However, the shape of the tail is right!!!