GamPP - Online scaled cross section calculation

$$\frac{d\sigma}{dt} = \frac{d\sigma}{d\Omega_{lab}} \frac{d\Omega_{lab}}{d\Omega_{cm}} \frac{d\Omega_{cm}}{dt} \tag{1}$$

$$\frac{d\sigma}{d\Omega_{lab}}(E_\gamma) = \frac{Y(E_\gamma)}{N_\gamma(E_\gamma) \cdot \Delta\Omega \cdot N_{scat} \cdot D_{eff}} \tag{2}$$

$$N_\gamma(E_\gamma) = \frac{Q_{in} \cdot X_{radlen} \cdot f_{brem}}{q_e} \tag{3}$$

$$N_{scat} = \frac{N_A \cdot \rho \cdot L \cdot f_{tgt}}{A} \tag{4}$$

$Y(E_\gamma)$ - Proton yield (coincidence).
$N_\gamma(E_\gamma)$ - Number of incident photons.
$\Delta\Omega$ - Spectrometer total solid angle (assumed to be 4 msr).
N_{scat} - Number of scatterers in the scatterers.
D_{eff} - Detector efficiency (assumed to be 90%)
Q_{in} - Total accumulated charge.
q_e - Charge of the electron.
X_{radlen} - Radition length (%)
f_{brem} - fraction of incident photons (of 140MeV tip).
N_A - Avogadro number.
ρ - Target density.
L - Target length.
A - Mass number.
f_{tgt} - Fraction of the target seen by the HRS.
θ_{lab} - Angle of scatterd proton in lab frame.

$$\frac{d\Omega_{lab}}{d\Omega_{cm}} = \frac{sin^2(\theta_{lab})}{sin^2(\theta_{cm})}[cos(\theta_{cm})cos(\theta_{lab}) + \gamma_{cm} sin(\theta_{cm}) sin(\theta_{lab})] \tag{5}$$

In the $\gamma - pp$ frame:

$$\gamma_{cm} = \frac{1}{\sqrt{1 - \beta_{cm}^2}} \tag{6}$$

$$\beta_{cm} = \frac{E_\gamma}{E_\gamma + 2m_p} \tag{7}$$

$$\frac{d\Omega_{cm}}{dt} = \frac{\pi}{E_{\gamma,cm} P_{\gamma,cm}} \tag{8}$$

$$E_{\gamma,cm} = \frac{E_\gamma 2m_p}{\sqrt{s}} = \frac{E_\gamma 2m_p}{p_{p1} + p_{p2}} \tag{9}$$

$$s_0 = (2m_p)^2 + 4m_p E_\gamma \tag{10}$$

$$s = (p^\mu_{p1} + p^\mu_{p2})^2 = 2m_p + 2\sqrt{P_1^2 + m_p^2}\sqrt{P_2^2 + m_p^2} - 2P_1 P_2 cos2\theta_{lab} \tag{11}$$

p_{p1}, p_{p2} - Momentum of outgoing protons.

we caculate and look at $s^{11}\frac{d\sigma}{dt}$