

# simulation update

Energy loss model versus Radiation XS model

Jie Liu

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# IDEA

To compare & check energy loss model:

1<sup>st</sup> way: *Monte Carlo step by step:*

use ionization, external bremsstrahlung,  
internal bremsstrahlung, born XS,

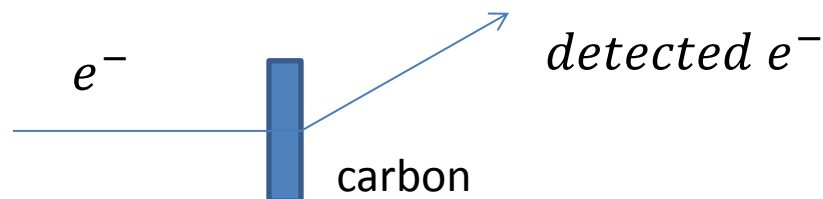
**Input:** fixed beam energy, fixed scattering angle

**Output:** generate detected electron energy distribution  
**weighed by born cross section**

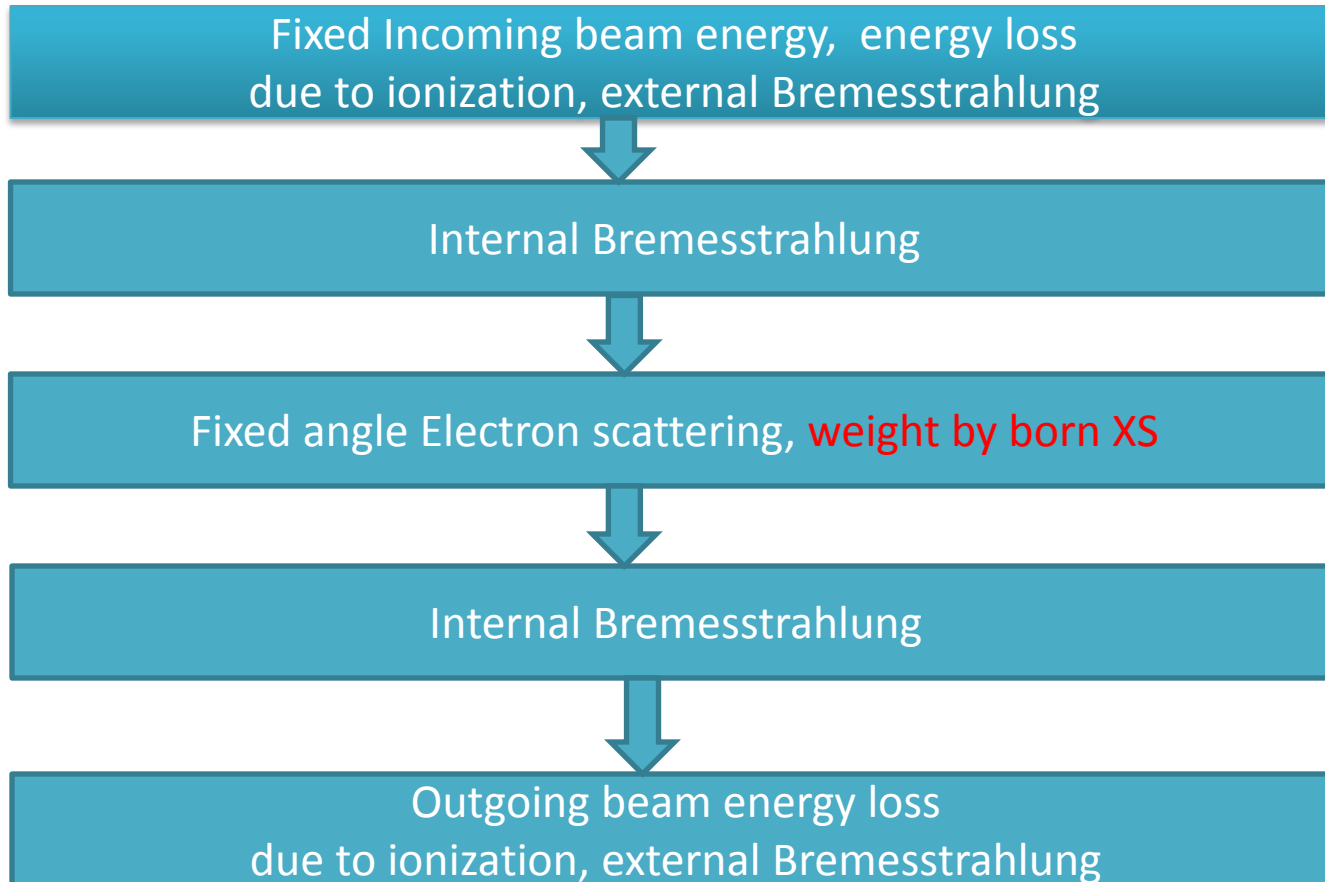
2<sup>nd</sup> way: *use radiation XS model (Stein et al. phys. Rev. D 12. 7)*

**Input:** fixed beam energy, uniform detected energy, fixed scattering angle

**Output:** the detected electron energy is uniform generated, then  
**weighted by radiation cross section**



## 1<sup>st</sup> way: Energy loss step by step



## 2<sup>nd</sup> way: Radiation XS

Fixed incoming beam energy

Uniform detected energy distribution,  
Fixed scattering angle  
weighted by Radiation XS

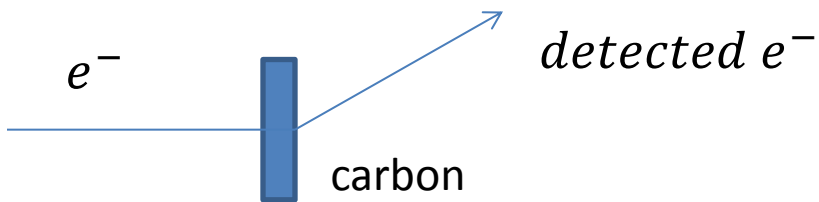
Radiation XS model (QFS) use from Stein (A82 equation)

$$\begin{aligned}
 \sigma_{qt} \equiv \left( \frac{d^2\sigma}{d\Omega dE_p} \right)_q &= \left( \frac{R\Delta E}{E_s} \right)^{b(t_b+t_r)} \left( \frac{\Delta E}{E_p} \right)^{b(t_a+t_r)} \left[ 1 - \frac{\xi/\Delta E}{1 - b(t_a+t_b+2t_r)} \right] \bar{\sigma}_q(E_s, E_p) \\
 &+ \int_{E_s - R\Delta E}^{E_s} \bar{\sigma}_q(E'_s, E_p) \left( \frac{E_s - E'_s}{E_p R} \right)^{b(t_a+t_r)} \left( \frac{E_s - E'_s}{E_s} \right)^{b(t_b+t_r)} \left[ \frac{b(t_b+t_r)}{E_s - E'_s} \phi \left( \frac{E_s - E'_s}{E_s} \right) + \frac{\xi}{2(E_s - E'_s)^2} \right] dE'_s \\
 &+ \int_{E_p + \Delta E}^{E_p} \bar{\sigma}_q(E_s, E'_p) \left( \frac{E'_p - E_p}{E'_p} \right)^{b(t_a+t_r)} \left[ \frac{(E'_p - E_p)R}{E_s} \right]^{b(t_b+t_r)} \left[ \frac{b(t_a+t_r)}{E'_p - E_p} \phi \left( \frac{E'_p - E_p}{E'_p} \right) + \frac{\xi}{2(E'_p - E_p)^2} \right] dE'_p,
 \end{aligned}
 \tag{A82}$$

where

$$R = \frac{M_T + 2E_s \sin^2(\frac{1}{2}\theta)}{M_T - 2E_p \sin^2(\frac{1}{2}\theta)}, \quad \Delta E = 5 \text{ MeV}, \quad \phi(v) = 1 - v + \frac{3}{4}v^2, \quad \bar{\sigma}(E_s, E_p) = \tilde{F}(q^2)\sigma_q(E_s, E_p).
 \tag{A83}$$

## Setup



Fixed Initial Energy: 2253MeV

Carbon before scattering: 0.5mm

Carbon after scattering: 0.5mm

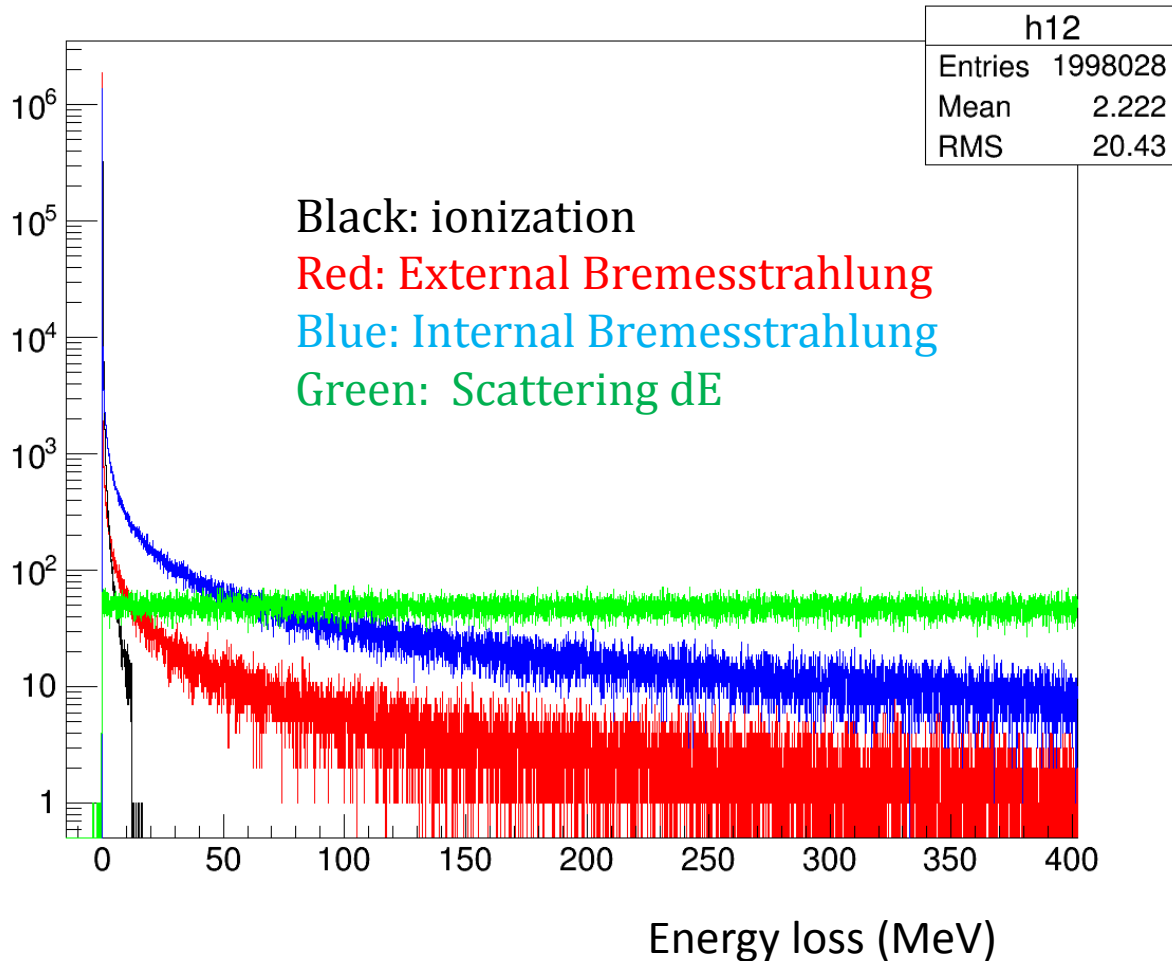
Fixed scattering angle: 0.107rad

Cross section (QFS)

No acceptance cut

# 1<sup>st</sup> way: energy loss step by step

Energy loss due to different process, **w/o weight born XS**



Fixed Initial Energy: 2253MeV

Carbon before scattering: 0.5mm

Carbon after scattering: 0.5mm

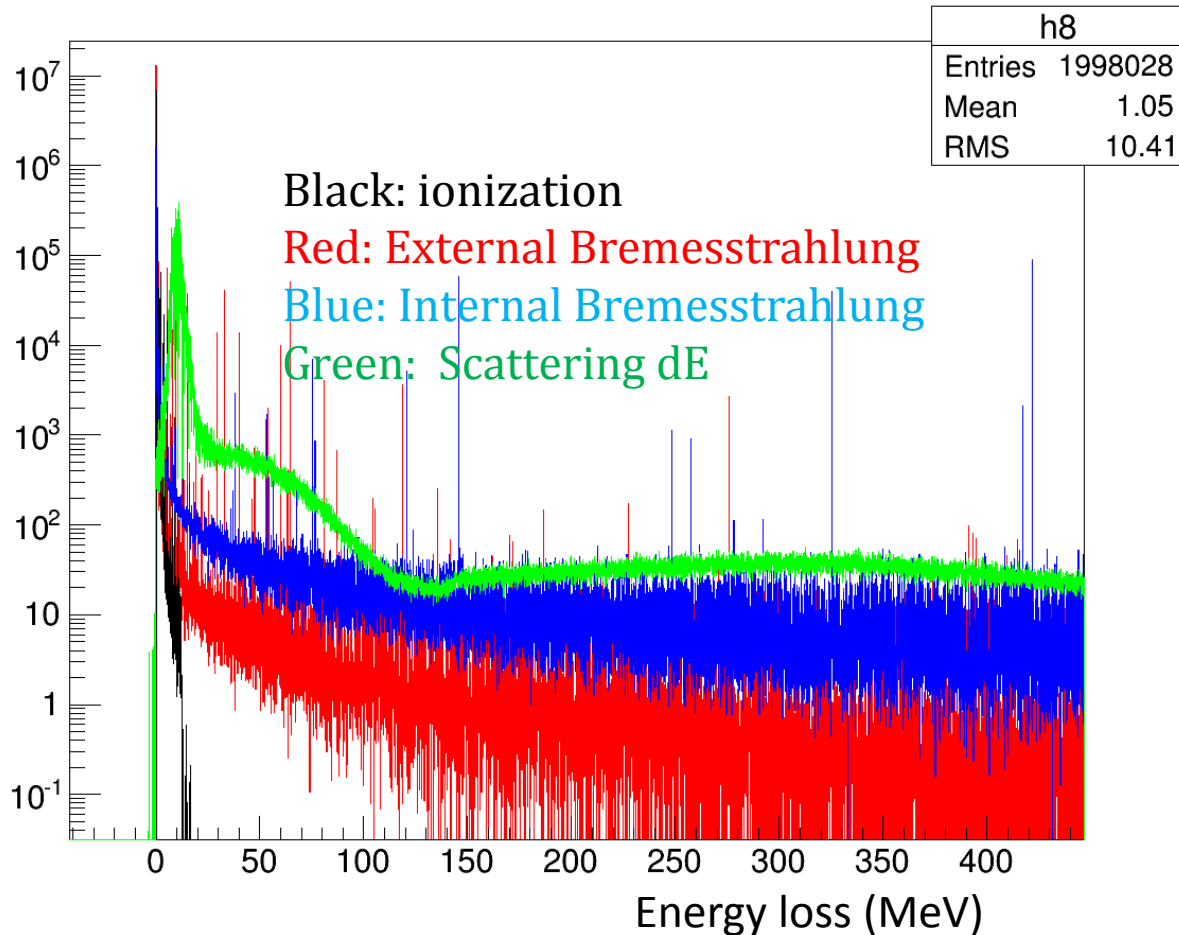
Fixed scattering angle: 0.107rad

Cross section (QFS)

No acceptance cut

# 1<sup>st</sup> way: energy loss step by step

Energy loss due to different process, **with weight born XS**



Fixed Initial Energy: 2253MeV

Carbon before scattering: 0.5mm

Carbon after scattering: 0.5mm

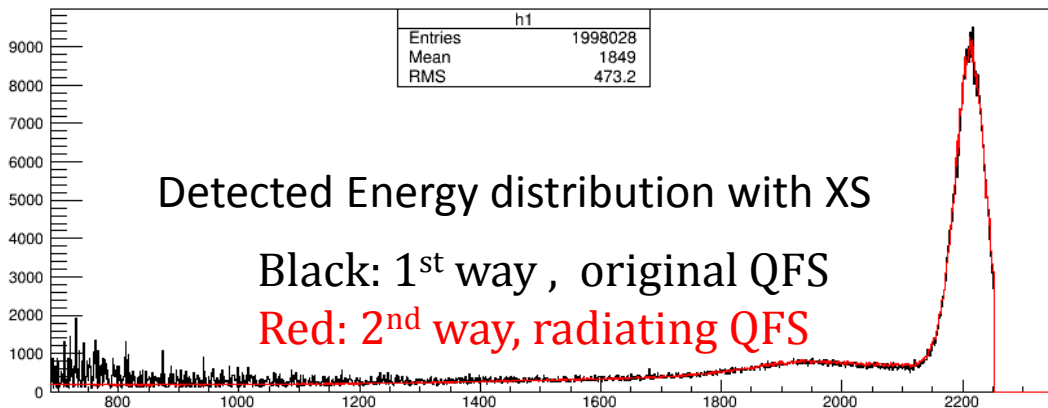
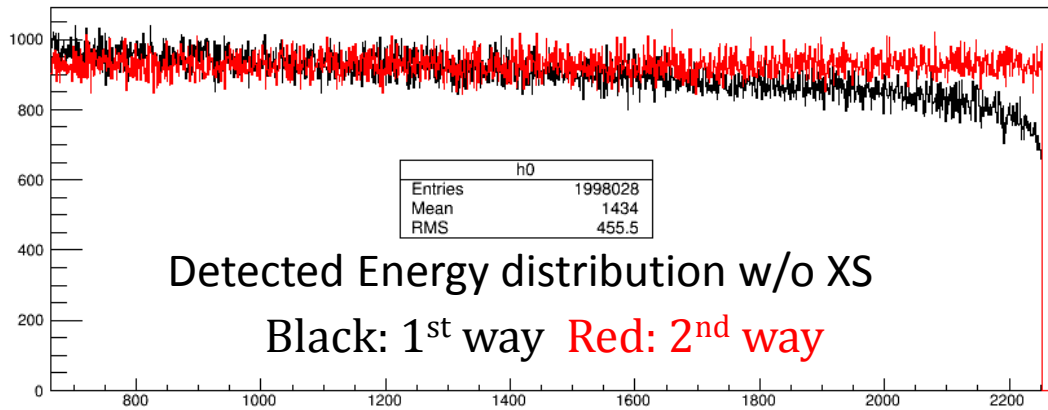
Fixed scattering angle: 0.107rad

Cross section (QFS)

No acceptance cut

# Dp Compare

## Two way comparison



Fixed Initial Energy: 2253MeV

Carbon before scattering: 0.5mm

Carbon after scattering: 0.5mm

Fixed scattering angle: 0.107rad

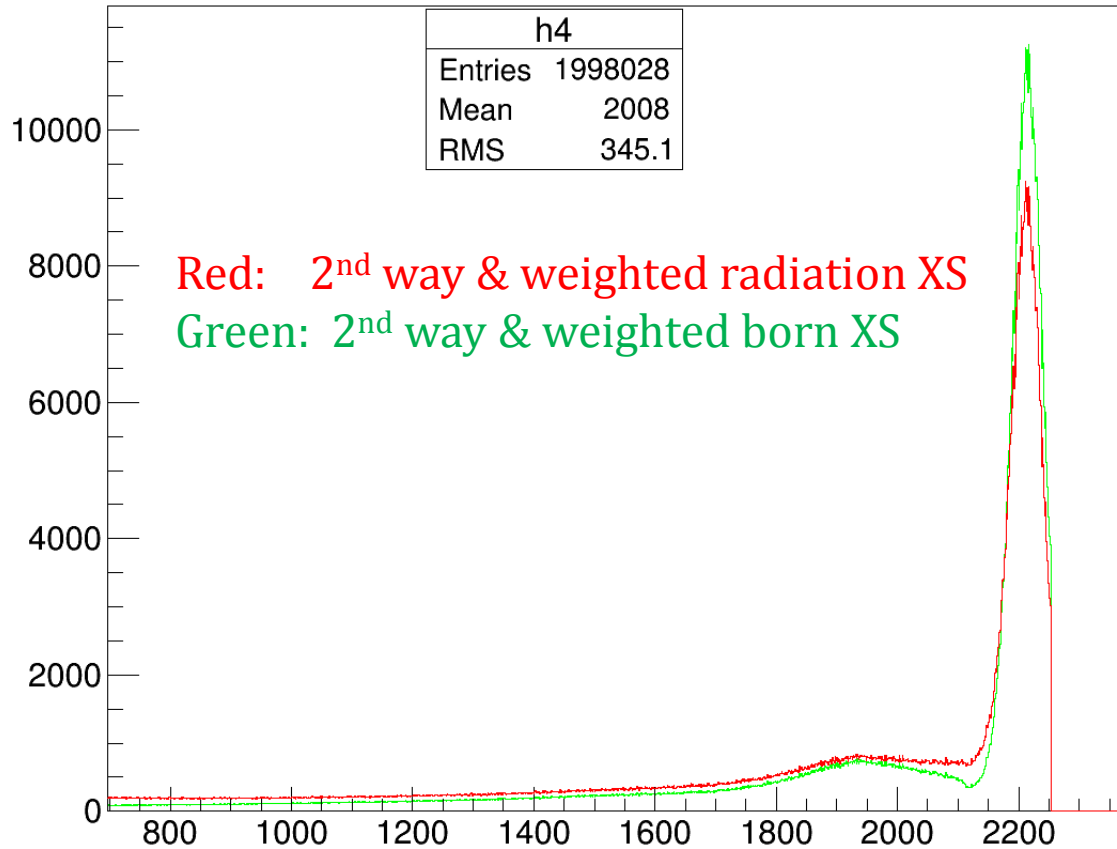
Cross section (QFS)

No acceptance cut



# Dp Compare

2<sup>nd</sup> way weighted by Radiation XS or Born XS



Fixed Initial Energy: 2253MeV

Carbon before scattering: 0.5mm

Carbon after scattering: 0.5mm

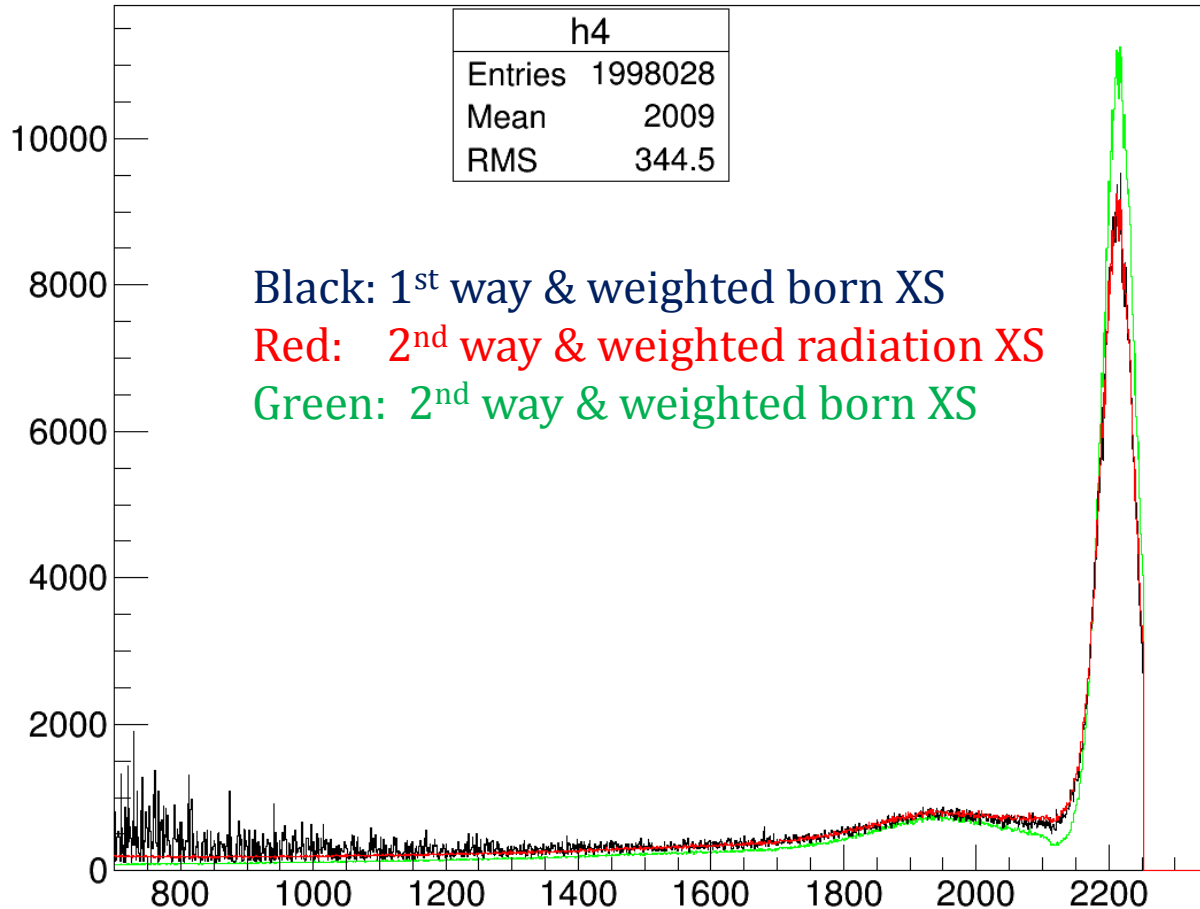
Fixed scattering angle: 0.107rad

Cross section (QFS)

No acceptance cut

# Dp Compare

Three plots Together (carbon thickness **1mm**)



Fixed Initial Energy: 2253MeV

Carbon before scattering: 0.5mm

Carbon after scattering: 0.5mm

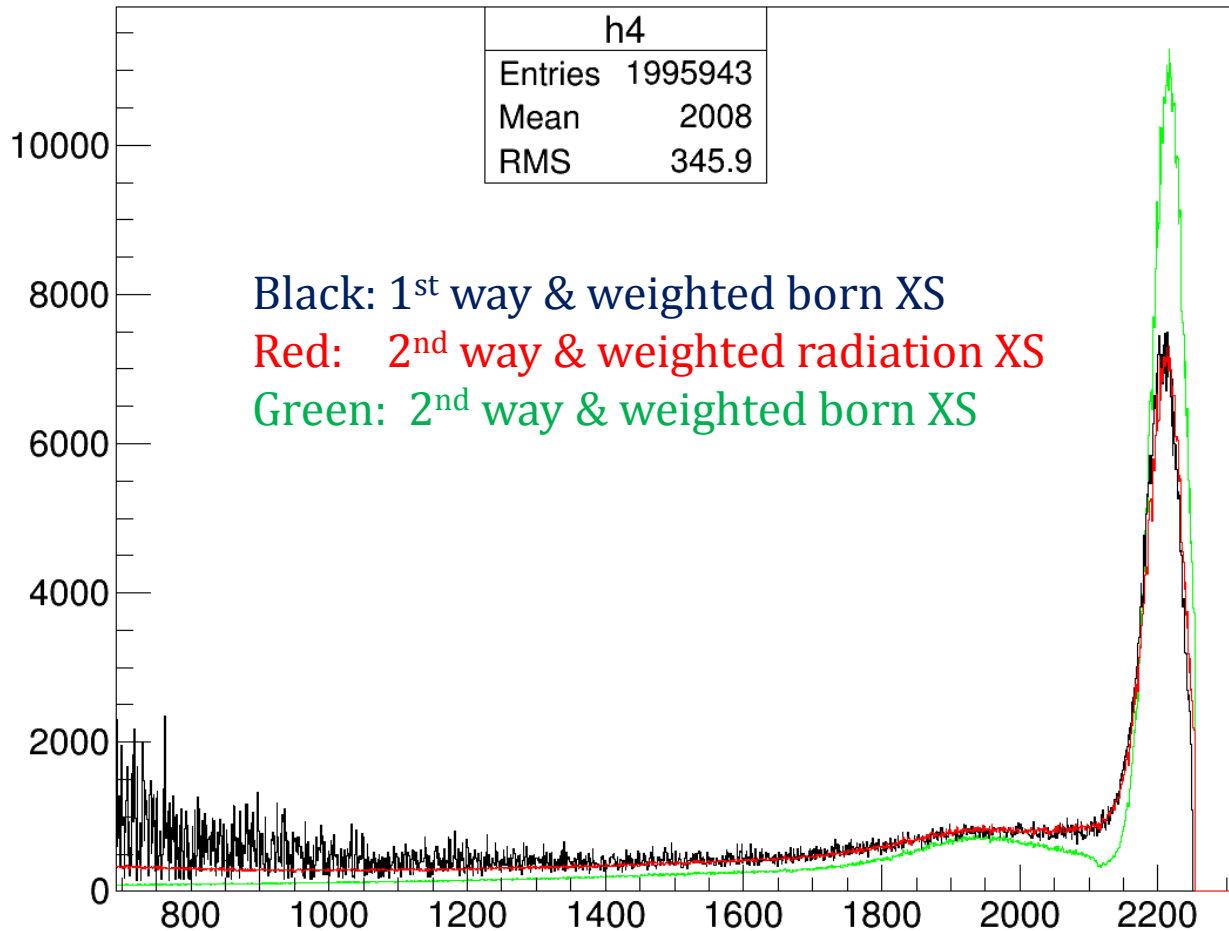
Fixed scattering angle: 0.107rad

Cross section (QFS)

No acceptance cut

# Dp Compare

Three plots Together (carbon thickness **1cm**)



Fixed Initial Energy: 2253MeV

Carbon before scattering: **5mm**

Carbon after scattering: **5mm**

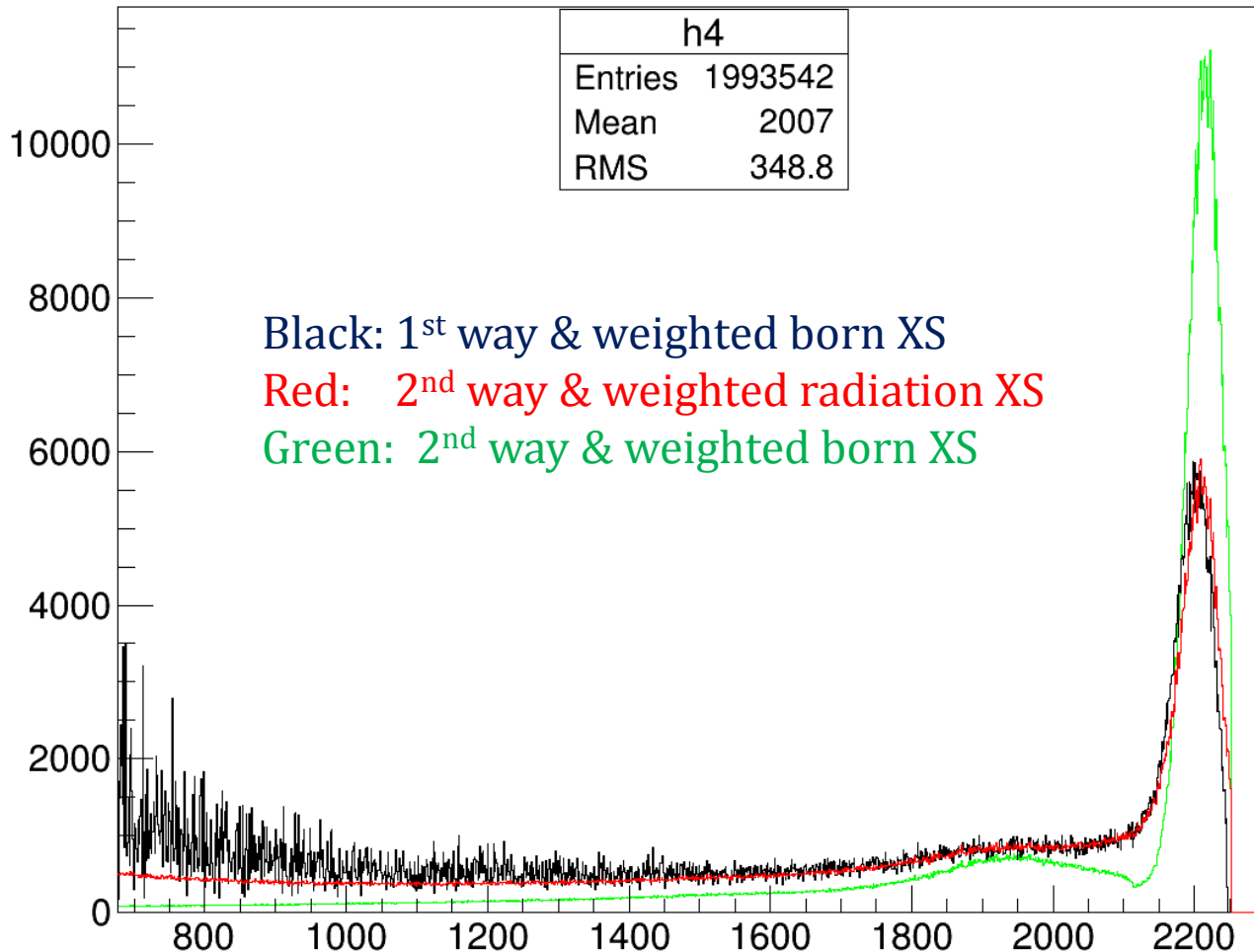
Fixed scattering angle: 0.107rad

Cross section (QFS)

No acceptance cut

# Dp Compare

Three plots Together (carbon thickness **2cm**)



Fixed Initial Energy: 2253MeV

Carbon before scattering: **1cm**

Carbon after scattering: **1cm**

Fixed scattering angle: 0.107rad

Cross section (QFS)

No acceptance cut

# Todo

- The dp agree with radiation model well
- Will do full simulation for beam dependence study when acceptance ready
- Work on snake code