Simulation update

- Energy loss

  Difference between g2psim and geant4 (HRSMC) → checked

- Packing fraction

  first try

Last Time

ionization

- The probability distribution of energy loss Δ by ionization is a Landau distribution, peaked at

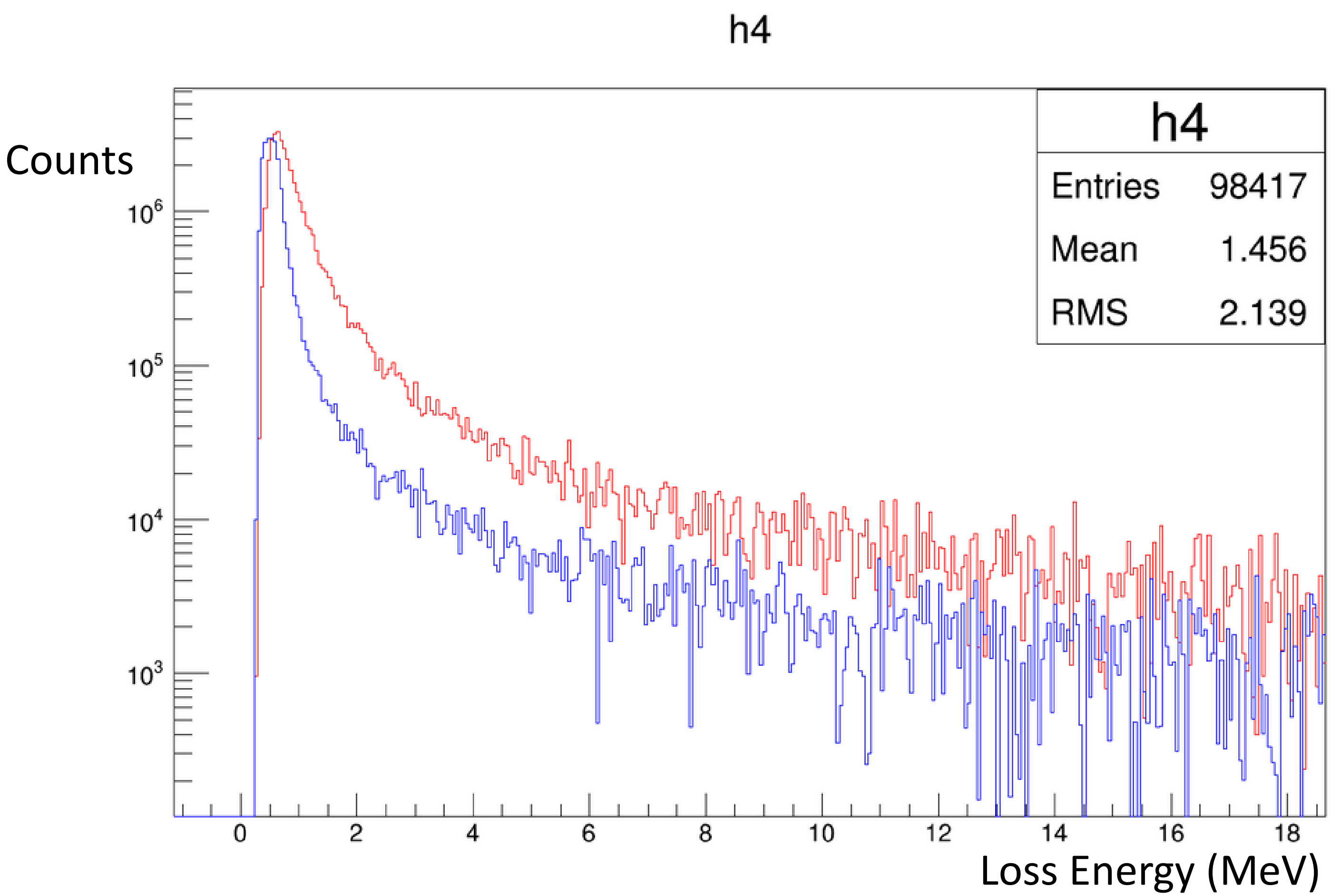
$$\begin{aligned}
\Delta_0 &= \xi\left[\ln\left(\frac{\xi}{\epsilon'}\right)+0.20\right] \\
\xi &= \frac{2\pi\alpha^2 N_A}{m_e\beta^2}\frac{Z}{A}d \\
\ln\epsilon' &= \ln\left[\frac{\left(1-\beta^2\right)I_0^2 Z^2}{2m_e\beta^2}\right]+\beta^2
\end{aligned}$$

- N_A Aagadro number, $\beta = v/c$, d is the averaged density multiplied by length, A is the averaged mass number, I_0 is the ionization energy of material

Last Time

Geant4 compared with g2psim

- Red: g2psim; Blue: geant4 ; cross section weighted
- Carbon without He, no field



Ionization fluctuation model

- Large fluctuations are due to small number of collisions of large energy transfers
- Characterised by $\kappa \sim$ ratio of mean energy loss to the maximum allowed energy transfer in a single collision with an atomic electron

$$\kappa = \frac{\xi}{E_{\max}}$$

$$\xi = \frac{2\pi z^2 e^4 N_{Av} Z \rho \delta x}{m_e \beta^2 c^2 A} = 153.4 \frac{z^2}{\beta^2} \frac{Z}{A} \rho \delta x \quad \text{keV},$$

- Heavy absorbers : κ >10 Gaussian distribustion
- Moderate absorbers: $0.01 < \kappa$ <10 , Vavilov
- Thin absorbers: $\kappa < 0.01$, with collisions numbers $N_c > 50$, Landau
- Very thin absorbers : $N_c < 50$ ($\kappa \ll 0.01$) , approximation model

Ionization fluctuation model

- **Eg. 0.1016cm C12 target**

- κ=17.666keV/2.253GeV*2.0=1.568*10^{-5}
- For the scattered electron (reaction point near C12 boundary) about ¼*0.1016cm, collisions $N_c < 50$

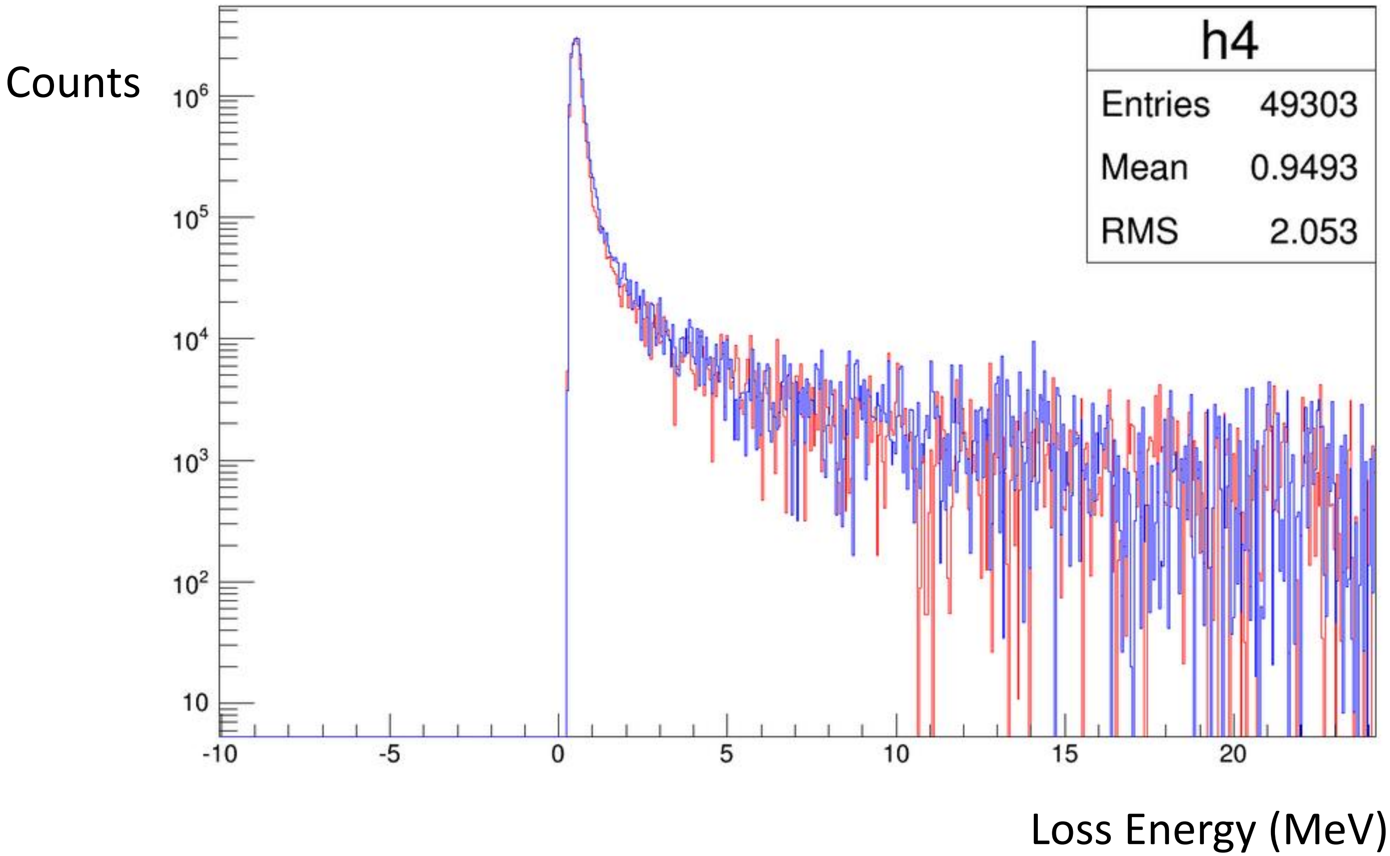
- Geant 4 use **Urban model** to simulate the fluctuation of the mean energy loss.
- General idea:
- Atoms have only two energy levels with binding energy E1 and E2.
- particle–atom interaction will then be an excitation with energy loss E1 or E2.
- Or an ionization with an energy loss distributed according to a function $g_E = 1/E^2$

- Can be used for any thickness of a medium.
- Approaching the limit of the validity of Landau's theory, the loss distribution approaches smoothly the Landau

New Result

Geant4 compared with g2psim

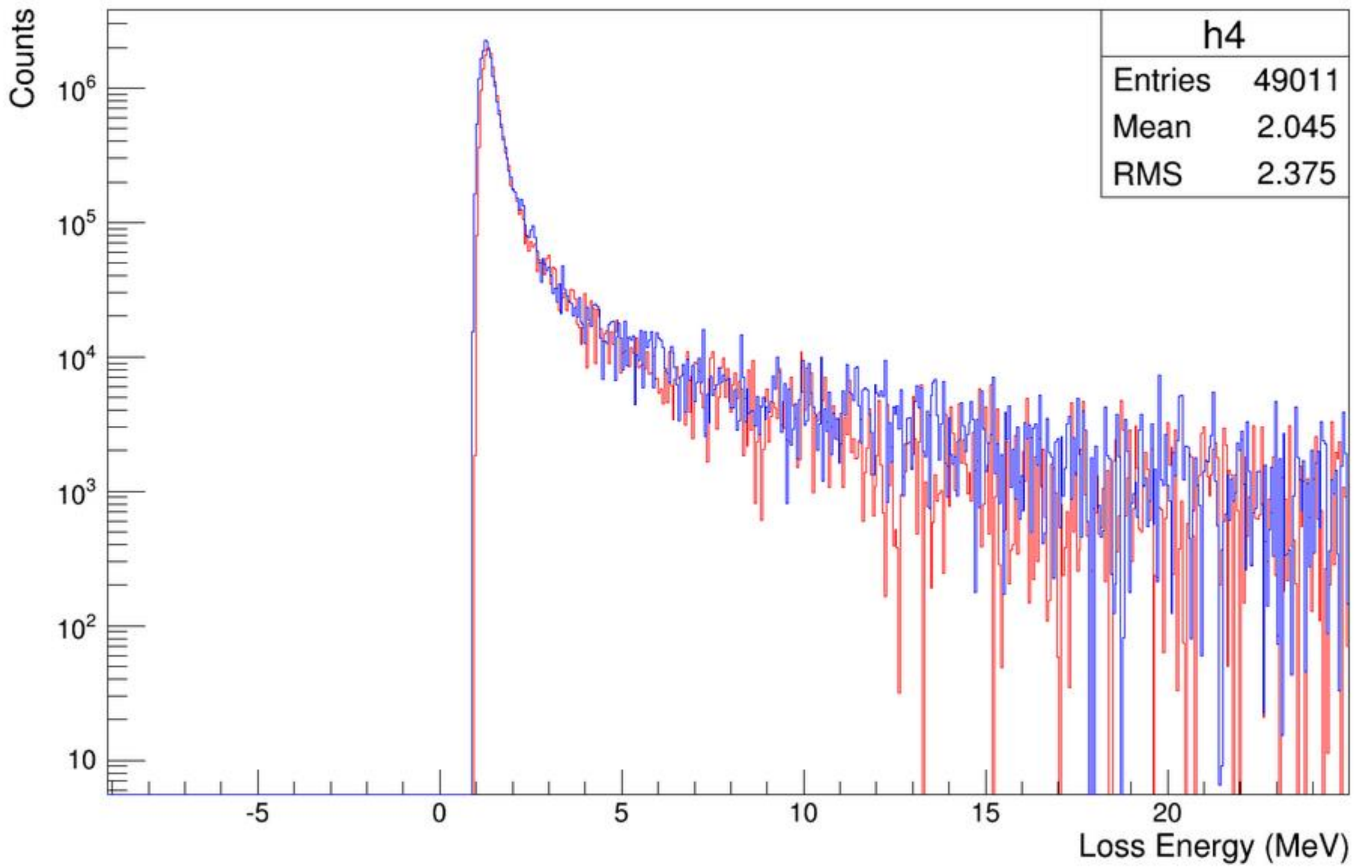
- Red: g2psim; Blue: geant4 ; cross section weighted
- Carbon without He, no field
- δ electron not considered



New Result

Geant4 compared with g2psim

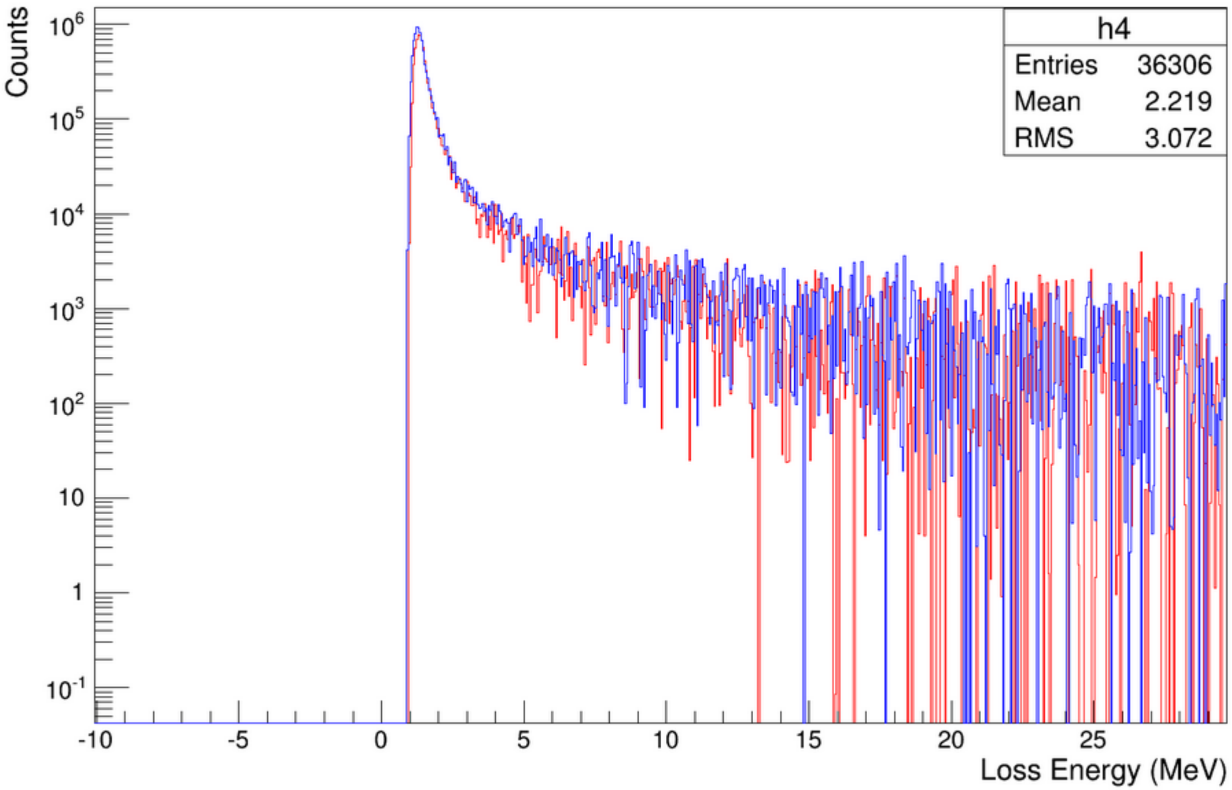
- Red: g2psim; Blue: geant4 ; cross section weighted
- Carbon with He, no field
- δ electron not considered



New Result

Geant4 compared with g2psim

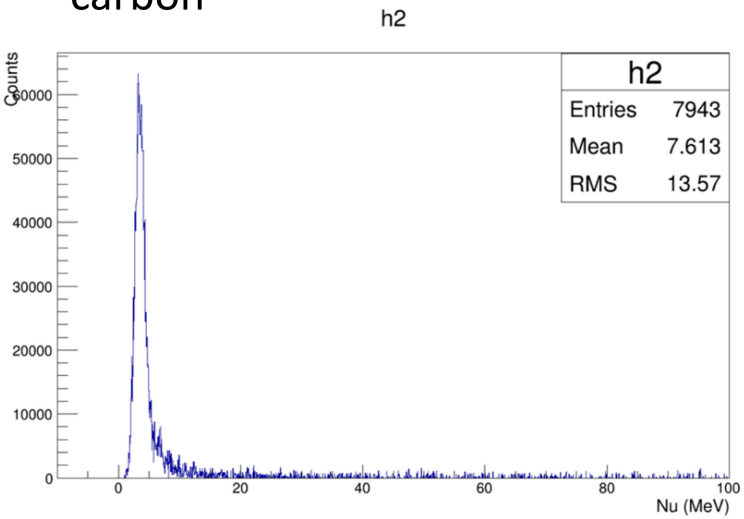
- Red: g2psim; Blue: geant4 ; cross section weighted
- Carbon without He, 2.5T field
- δ electron not considered



Packing fraction

- Rate yield ratio: carbon dilution run to packing fraction run
- $\frac{Rate_{C12}}{Rate_{NH3}}=$
- $\frac{\frac{d_{NH3}}{M_{NH3}}*T_{cell}*pf*(\sigma_N+3*\sigma_H)+\frac{d_{He}}{M_{He}}*(T_{cell}*(1-pf)+T_{out})*\sigma_{He+}+\frac{d_{Al}}{M_{Al}}*(T_{Al})*\sigma_{Al}}{\frac{d_C}{M_C}*(T_C)*\sigma_C+\frac{d_{He}}{M_{He}}*(T_{new}*+T_{out})*\sigma_{He+}+\frac{d_{Al}}{M_{Al}}*(T_{Al})*\sigma_{Al}}$
- Still checking physics model

carbon



Nitrogen