

Simulation update

Packing fraction

Last time

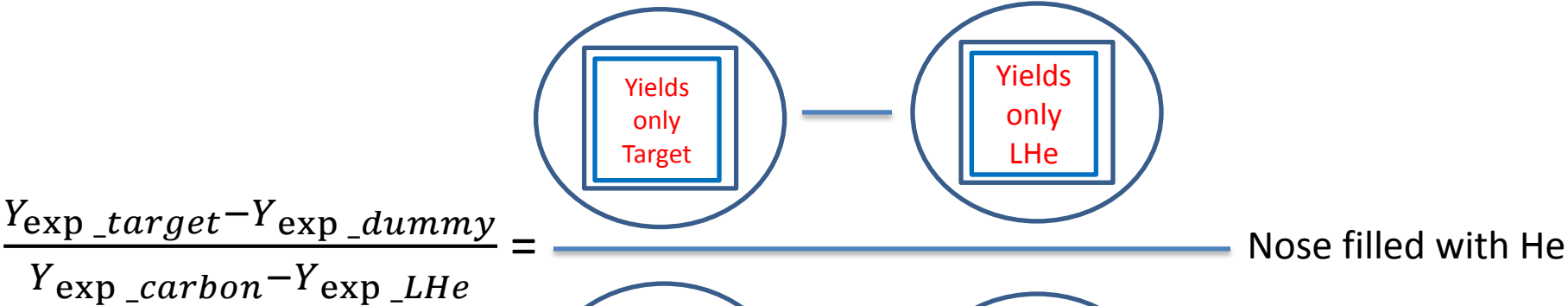
1st method

The diagram illustrates the 1st method for yield calculation using a balance scale. The left pan contains two boxes: "Yields only Target" and "Yields only LHe". The right pan contains a single box labeled "LHe".

$$\frac{Y_{\text{exp_target}} - Y_{\text{exp_dummy}}}{Y_{\text{exp_empty}}} = \frac{\text{Yields only Target} + \text{Yields only LHe}}{\text{LHe}}$$
$$= \frac{\left[\frac{d_{\text{NH}_3}}{M_{\text{NH}_3}} T_{\text{cell}} * pf * (\sigma_{\text{N}} + 3 * \sigma_{\text{H}}) + \frac{d_{\text{He}}}{M_{\text{He}}} T_{\text{cell}} * (1 - pf) * \sigma_{\text{He}} \right] - \frac{d_{\text{He}}}{M_{\text{He}}} T_{\text{cell}} * \sigma_{\text{He}}}{\frac{d_{\text{He}}}{M_{\text{He}}} T_{\text{total}} * \sigma_{\text{He}}}$$

Last time

2nd method



$$= \frac{\left[\frac{d_{\text{NH}_3}}{M_{\text{NH}_3}} T_{\text{cell}} * pf * (\sigma_{\text{N}} + 3 * \sigma_{\text{H}}) + \frac{d_{\text{He}}}{M_{\text{He}}} T_{\text{cell}} * (1 - pf) * \sigma_{\text{He}} \right] - \frac{d_{\text{He}}}{M_{\text{He}}} T_{\text{cell}} * \sigma_{\text{He}}}{\frac{d_{\text{C}}}{M_{\text{C}}} T_{\text{c}} * \sigma_{\text{C}} - \frac{d_{\text{He}}}{M_{\text{He}}} (T_{\text{c}} - T_{\text{endcap}}) * \sigma_{\text{He}}}$$

Correction factor

- Radiation effect δ
- Electron straggling in the target δ_t

$$\frac{d\sigma}{d\Omega} \Big|_{meas} = \frac{d\sigma}{d\Omega} \Big|_{Rosenbluth} e^{(\delta + \delta_t)}$$

- For our system, $Q^2 \approx 0.5 \text{ GeV}^2$, the internal bremsstrahlung equals two external radiator with $t \approx 0.01$
- Target thickness $t \approx 0.03$ straggling effect is very important

Radiation effect

$$\begin{aligned}
 \delta = & \frac{-\alpha}{\pi} \left(\frac{28}{9} - \frac{13}{6} \ln \left(\frac{-q^2}{m^2} \right) + \left(\ln \frac{-q^2}{m^2} - 1 + 2Z \ln \eta \right) \left(2 \ln \frac{E_1}{\Delta E} - 3 \ln \eta \right) - \Phi \left(\frac{E_3 - E_1}{E_3} \right) - Z^2 \ln \frac{E_4}{M} \right. \\
 & + Z^2 \ln \frac{M}{\eta \Delta E} \left(\frac{1}{\beta_4} \ln \frac{1 + \beta_4}{1 - \beta_4} - 2 \right) + \frac{Z^2}{\beta_4} \left\{ \frac{1}{2} \ln \frac{1 + \beta_4}{1 - \beta_4} \ln \frac{E_4 + M}{2M} - \Phi \left[- \left(\frac{E_4 - M}{E_4 + M} \right)^{1/2} \left(\frac{1 + \beta_4}{1 - \beta_4} \right)^{1/2} \right] \right\} \\
 & + Z \left[\Phi \left(- \frac{M - E_3}{E_1} \right) - \Phi \left(\frac{M(M - E_3)}{2E_3E_4 - ME_1} \right) + \Phi \left(\frac{2E_3(M - E_3)}{2E_3E_4 - ME_1} \right) + \ln \left| \frac{2E_3E_4 - ME_1}{E_1(M - 2E_3)} \right| \ln \left(\frac{M}{2E_3} \right) \right. \\
 & - Z \left[\Phi \left(- \frac{E_4 - E_3}{E_3} \right) - \Phi \left(\frac{M(E_4 - E_3)}{2E_1E_4 - ME_3} \right) + \Phi \left(\frac{2E_1(E_4 - E_3)}{2E_1E_4 - ME_3} \right) + \ln \left| \frac{2E_1E_4 - ME_3}{E_3(M - 2E_1)} \right| \ln \left(\frac{M}{2E_1} \right) \right. \\
 & \quad \left. - Z \left[\Phi \left(- \frac{M - E_1}{E_1} \right) - \Phi \left(\frac{M - E_1}{E_1} \right) + \Phi \left(\frac{2(M - E_1)}{M} \right) + \ln \left| \frac{M}{2E_1 - M} \right| \ln \left(\frac{M}{2E_1} \right) \right] \right. \\
 & \quad \left. + Z \left[\Phi \left(- \frac{M - E_3}{E_3} \right) - \Phi \left(\frac{M - E_3}{E_3} \right) + \Phi \left(\frac{2(M - E_3)}{M} \right) + \ln \left| \frac{M}{2E_3 - M} \right| \ln \left(\frac{M}{2E_3} \right) \right] \right) \\
 & \left. - \frac{\alpha}{\pi} \left(- \Phi \left(\frac{E_1 - E_3}{E_1} \right) + \frac{Z^2}{\beta_4} \left\{ \Phi \left[\left(\frac{E_4 - M}{E_4 + M} \right)^{1/2} \left(\frac{1 - \beta_4}{1 + \beta_4} \right)^{1/2} \right] - \Phi \left[\left(\frac{E_4 - M}{E_4 + M} \right)^{1/2} \right] + \Phi \left[- \left(\frac{E_4 - M}{E_4 + M} \right)^{1/2} \right] \right\} \right) \right).
 \end{aligned}$$

Vacuum , vertex, recoil effect, dynamical effect

Rev. Mod. Phys, 1969

Straggling effect

$$\delta_t = - \left\{ \left[b_w t_{iw} + \frac{1}{2} b T \right] \ln \left(E_1 / \eta^2 \Delta E \right) \right. \\ \left. + \left[b_w t_{fw} + \frac{1}{2} b T \right] \ln \left(E_3 / \Delta E \right) \right\}$$

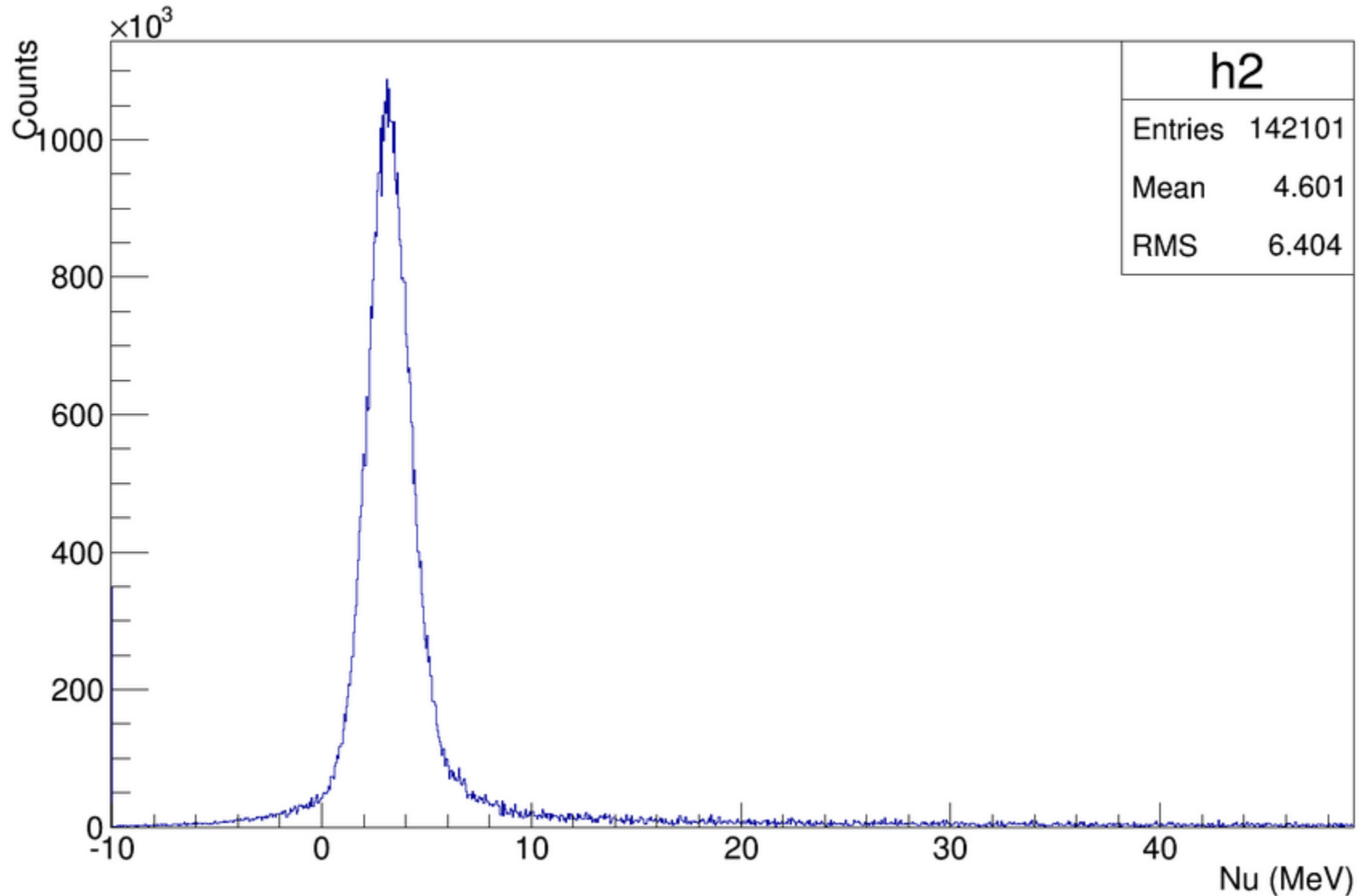
- t_{fw} : final windows thickness
- t_{iw} : initial windows thickness
- T : target thickness

In units of radiation length

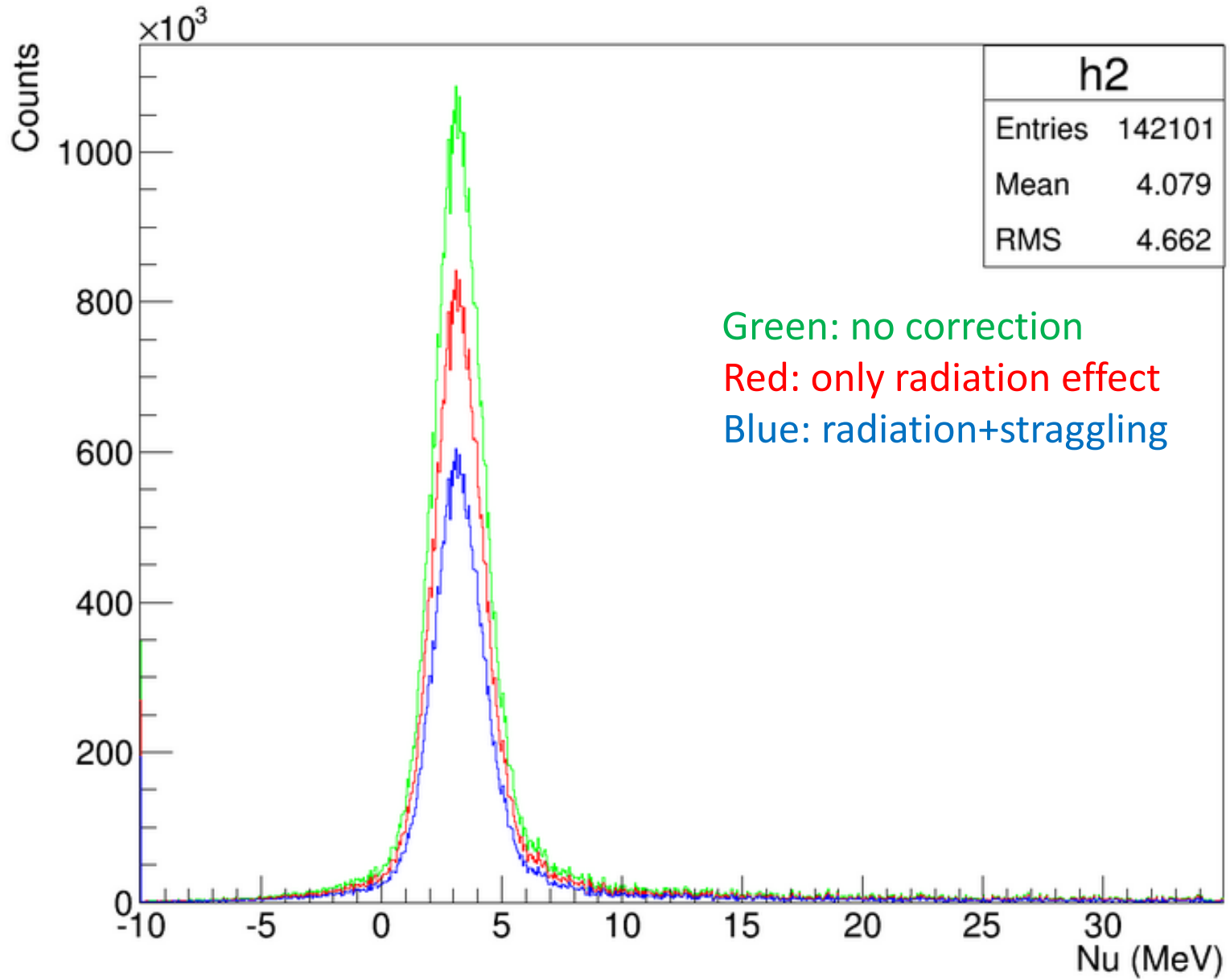
- b_w b : depends on material, close to 4/3
- $\delta_t \approx -0.33$
- $\delta \approx -0.26$

Before correction (nitrogen in target)

Born cross section distribution

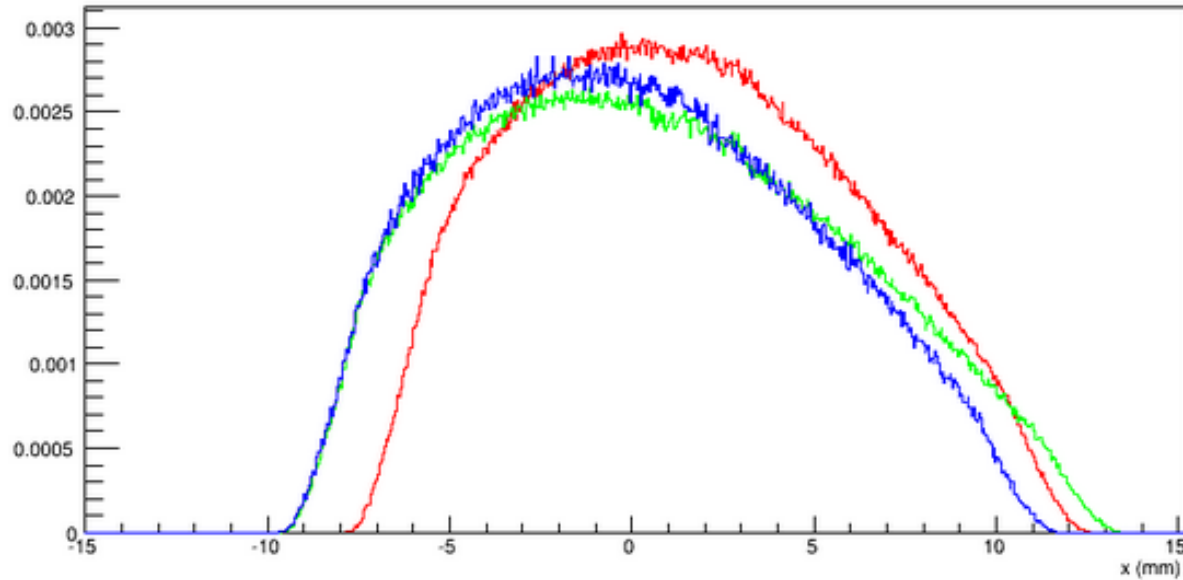


distribution



Beam position

Lrb.tgt_0_x



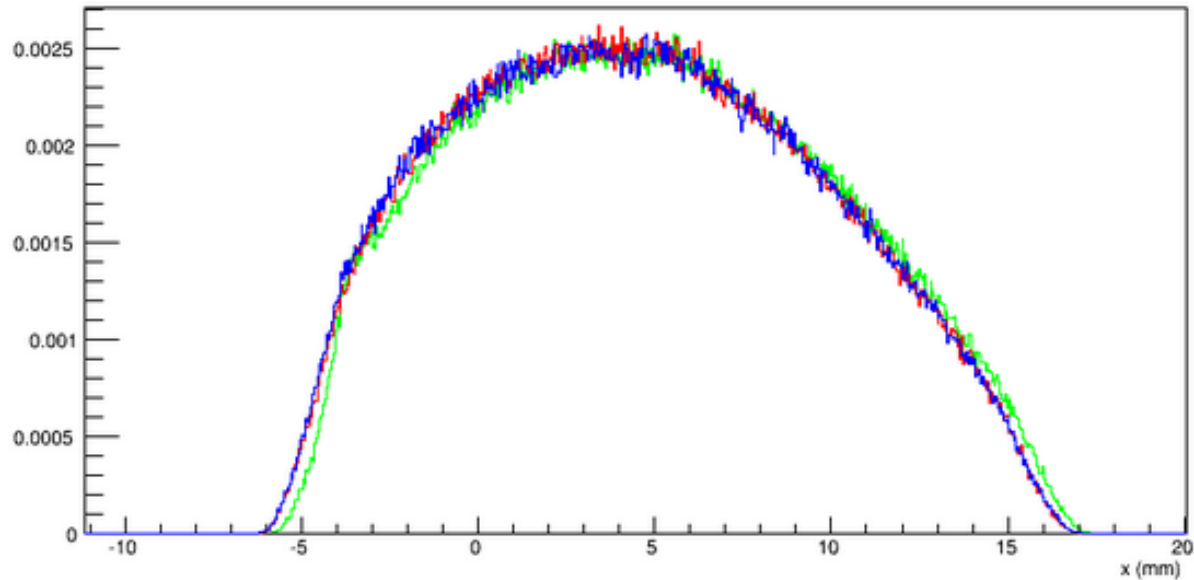
Packing fraction run:

Green: 3503

Red: 3574

Blue: 3864

Lrb.tgt_0_x



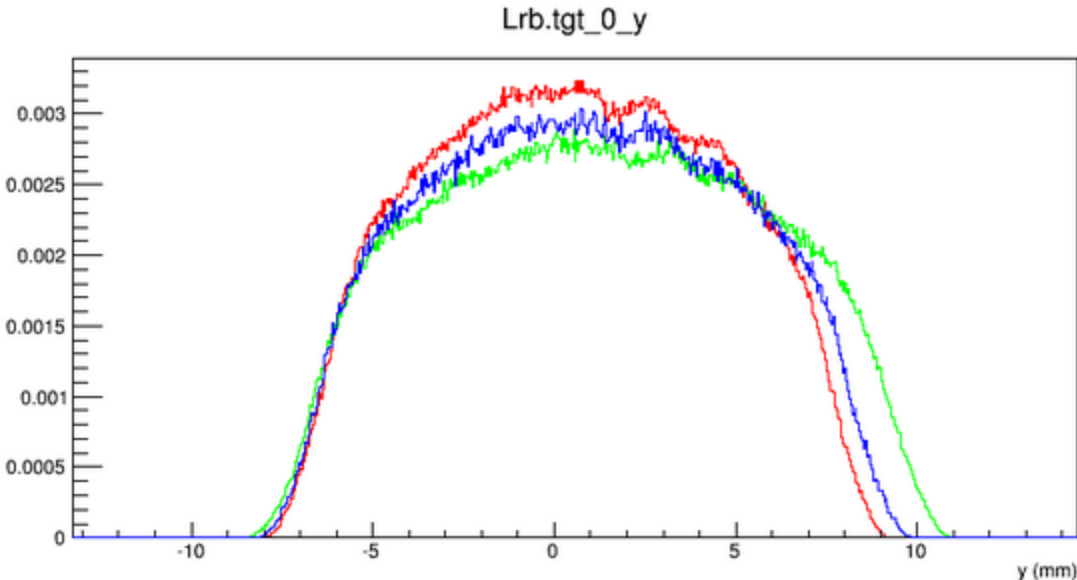
Dilution run:

Green: carbon

Red: dummy

Blue: empty

Beam position

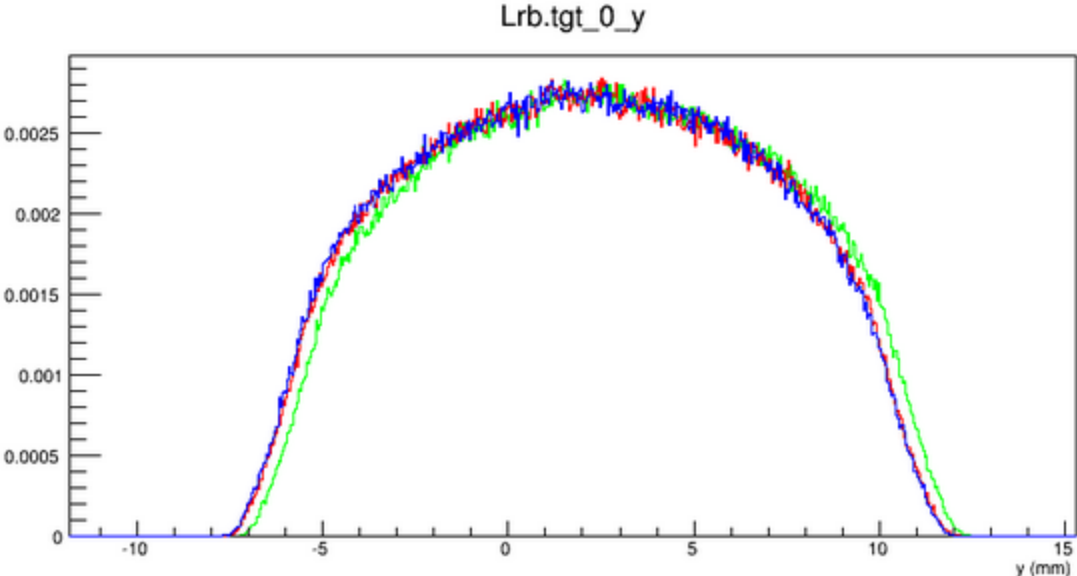


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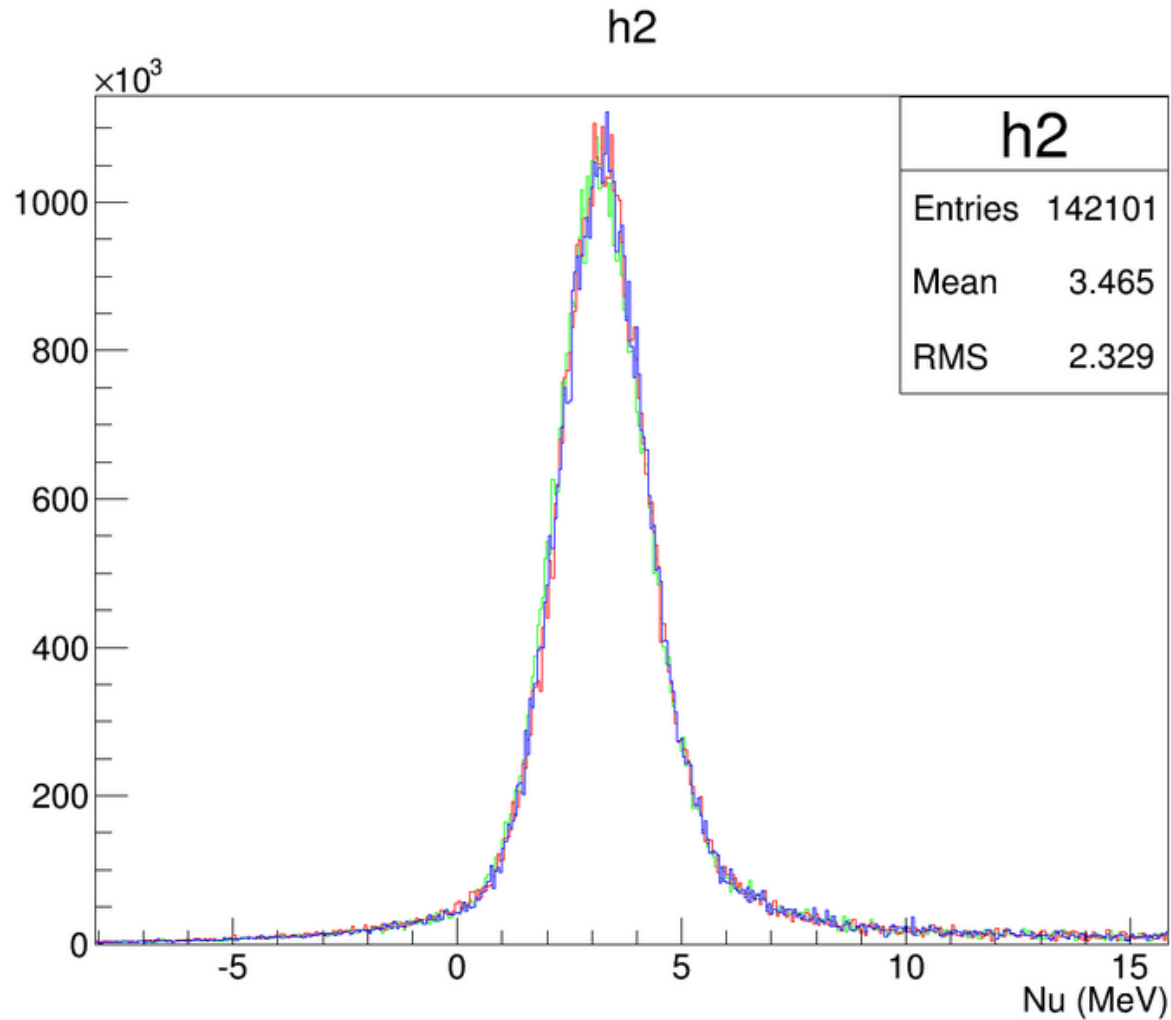
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Before correction



Packing fraction run:

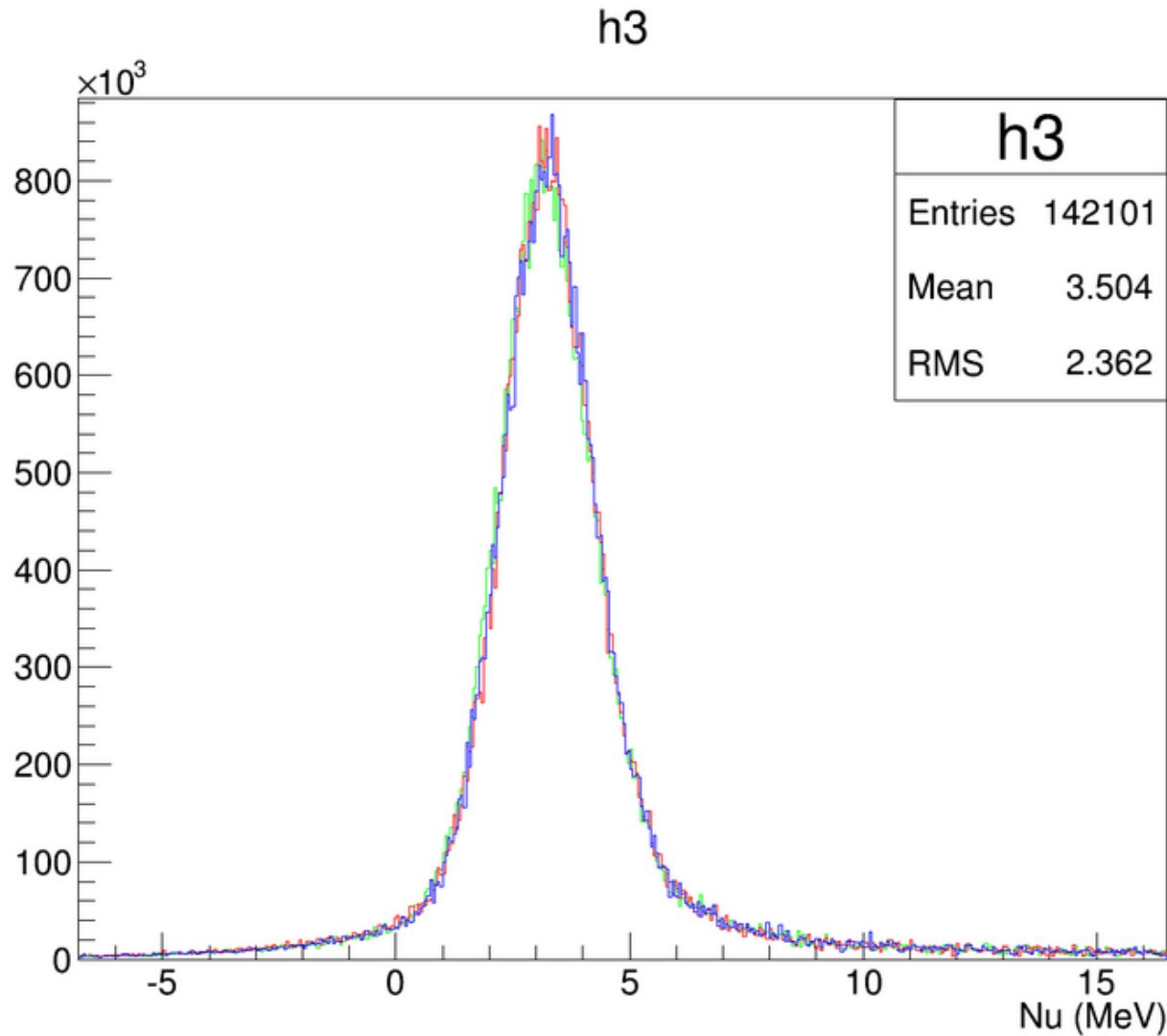
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Blue: 3864

less than 4.5%

Only radiation correction



Packing fraction run:

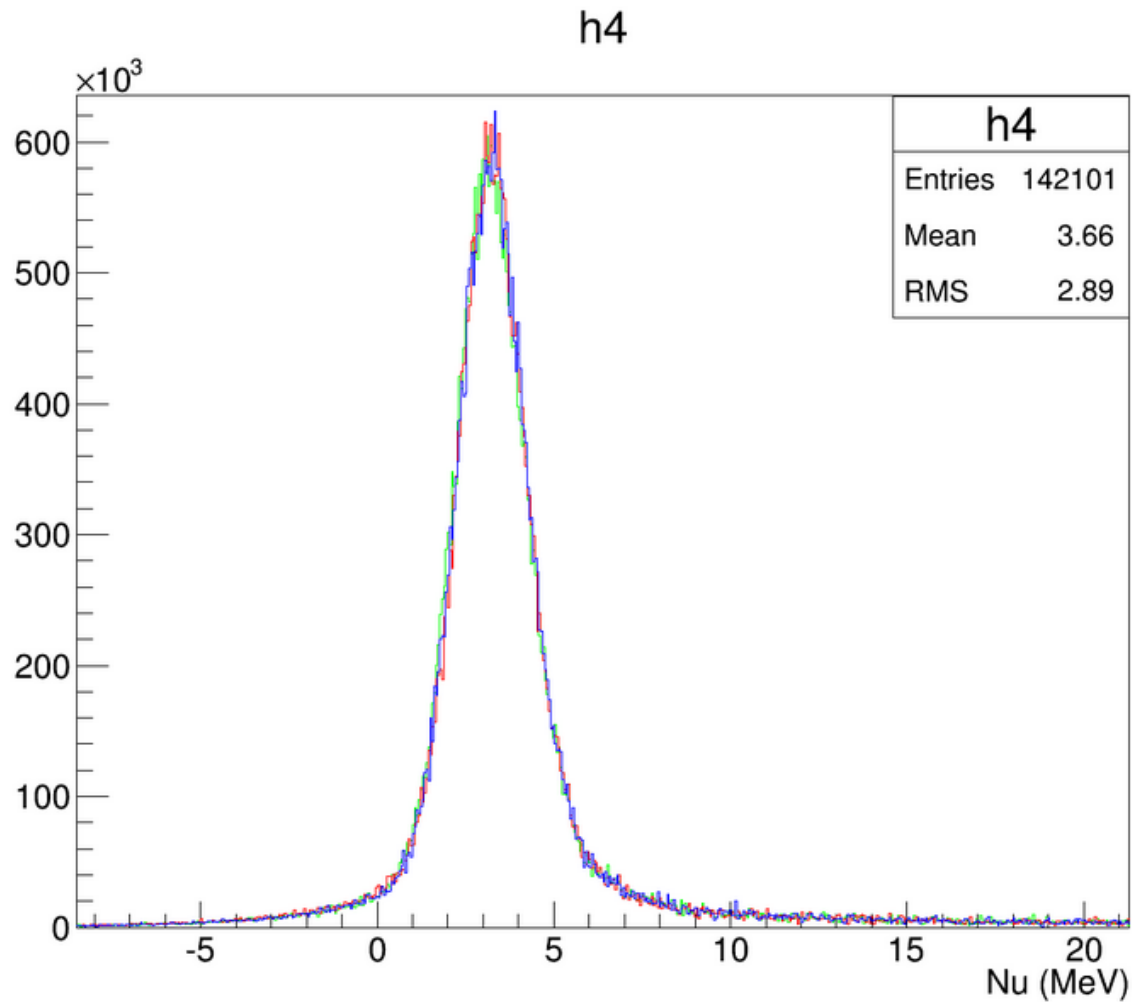
Green: 3503

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Less than 4.5 %

Radiation + straggling



Packing fraction run:

Green: 3503

Red: 3574

Blue: 3864

Less than 4.5%

Todo

- Huge rates deviation still exists.
- Not due to beam position? So ...
- Other material...