

Packing Fraction update
10/19/16

Reminder

$$pf = \left(\frac{L_{total}}{L_{tg}} \right) \left(\frac{Y_{production}}{Y_{dummy}} - 1 \right) \left(\frac{\frac{\rho_N}{M_N} \sigma_N + \frac{\rho_H}{M_H} \sigma_H}{\frac{\rho_{He}}{M_{He}} \sigma_{He}} - 1 \right)^{-1}$$

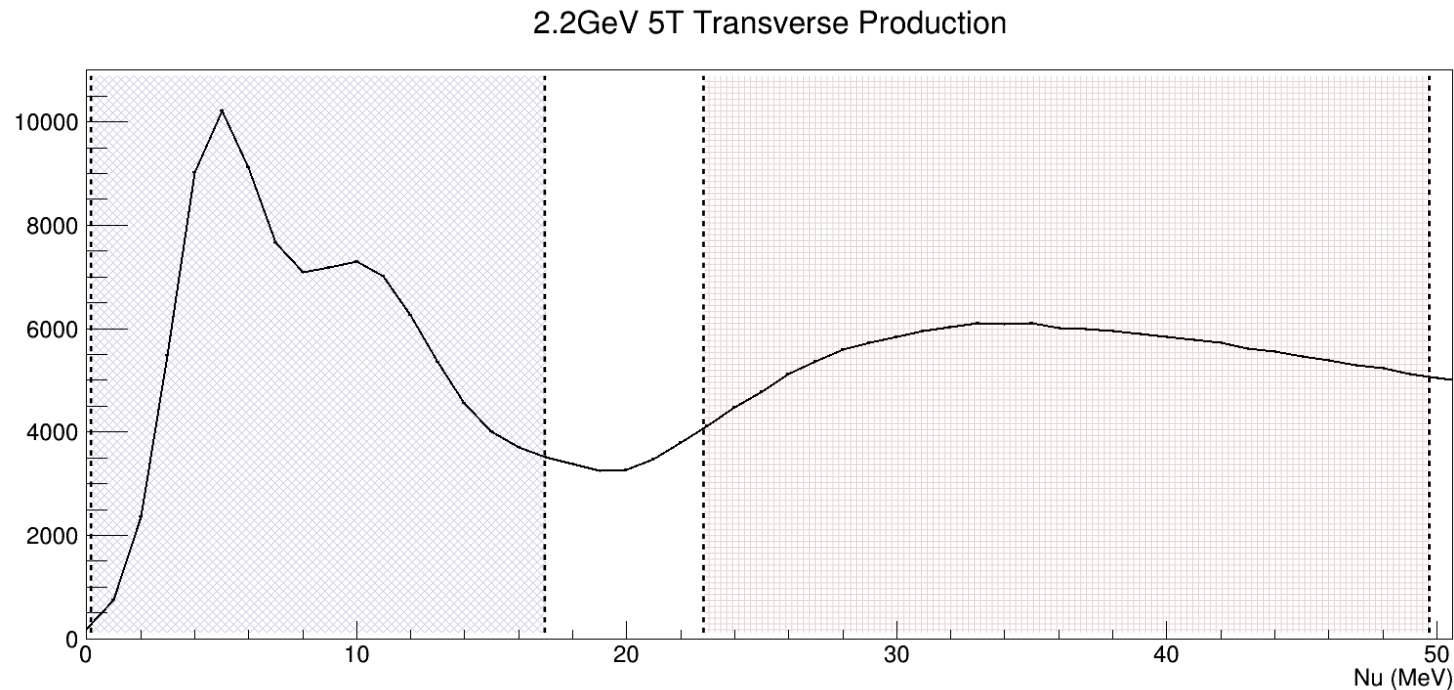
$Y_{production/dummy}$ \longrightarrow obtained from integrating the elastic peak from production/dummy runs

$\sigma_{N/H/He}$ \longrightarrow obtained from integrating the elastic peak from g2psim

Sources of uncertainty:

- Production yield integral (small, statistical)
- Sensitivity of data to fit method for QE subtraction
- Spread in inputs to elastic g2psim model
- **Uncertainty in model output?**
- **Target length uncertainty?**

Isolating elastic peak using fits

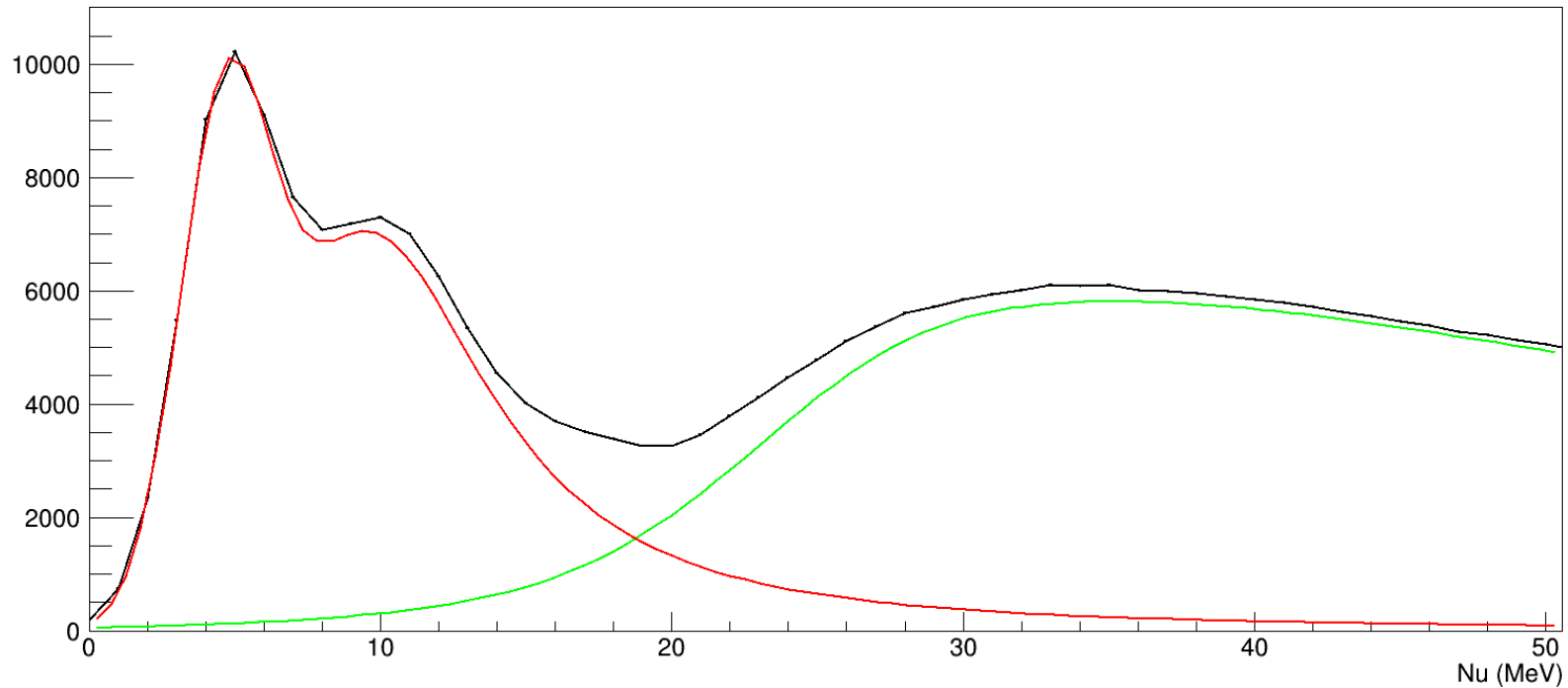


Steps:

- Gaussian fit to both elastic peaks (blue region).
- Gaussian-landau fit applied **only** to He elastic peak using starting parameters from gaussian. (range 9-17 MeV).
- Total elastic peak fit as gaussian + gaussian-landau (range 0-17 MeV).
- Gaus+Gaus+Gaus fit to quasi-elastic (red region) in range 23-50 MeV using starting parameters from simulation.
- Total fit to all peaks.

Isolating elastic peak using fits

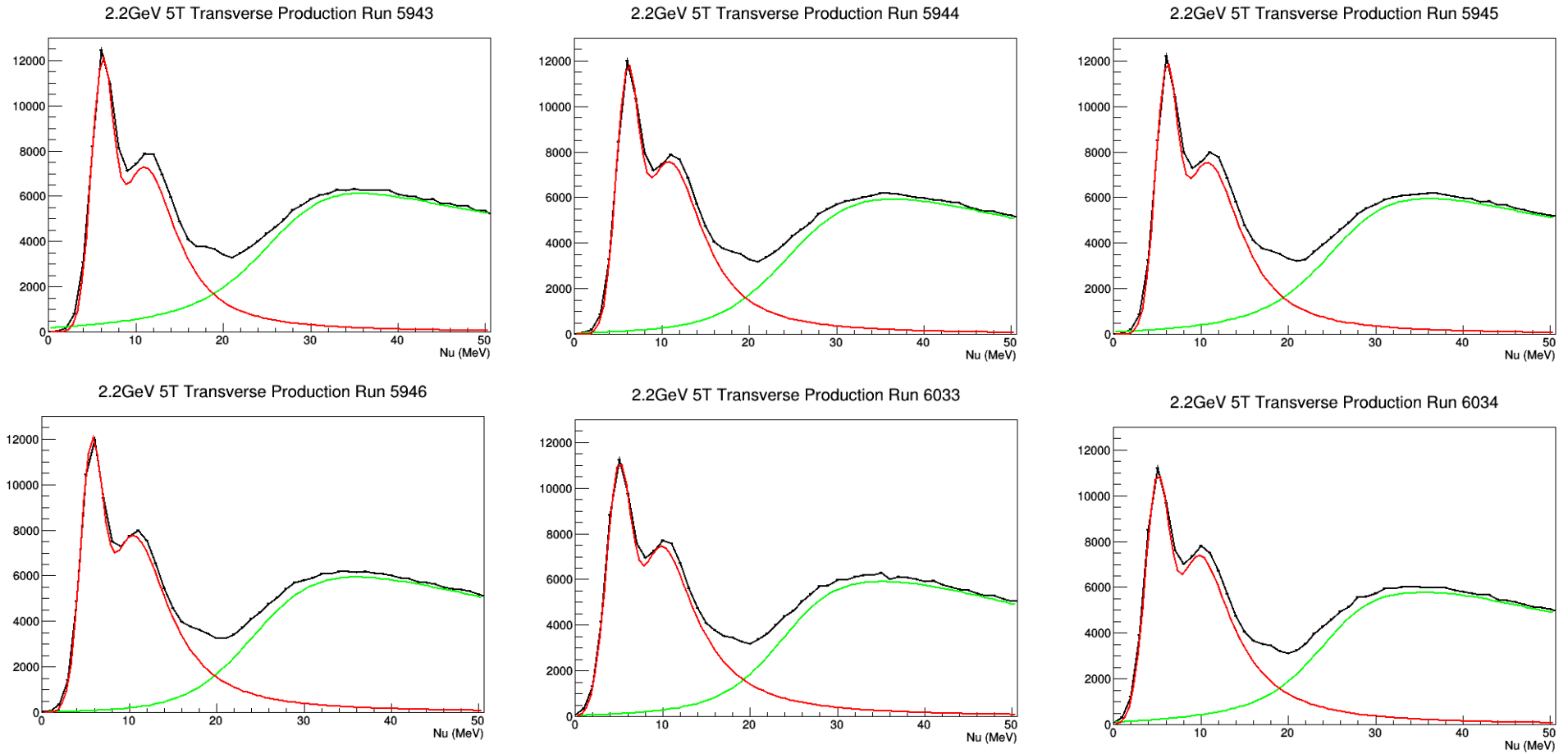
2.2GeV 5T Transverse Production



Uncertainty in fit method:

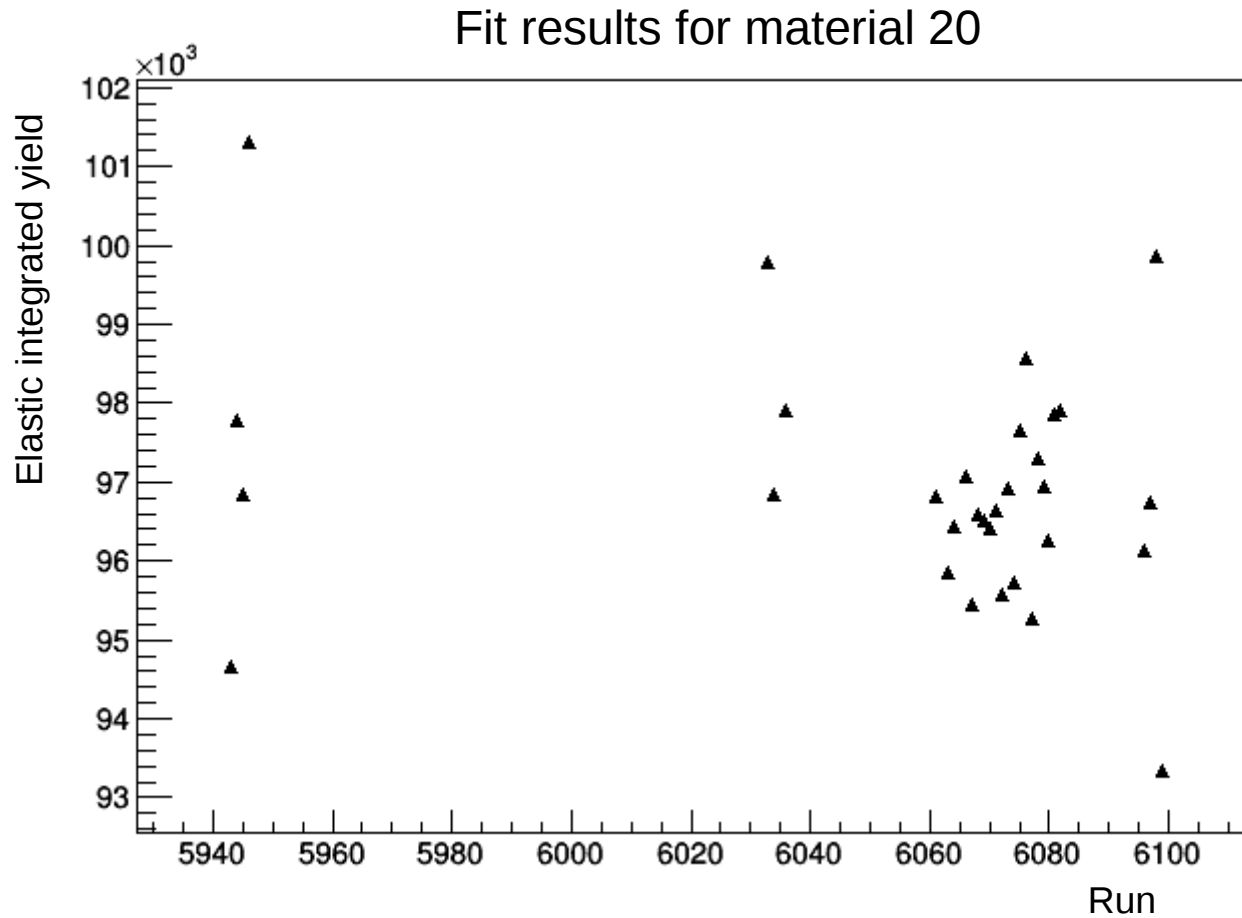
- Largest source of uncertainty (integrated area is very sensitive to large parameter fit!)
- Same fit done on every elastic production run on a given material.
- Average of ALL runs used in final calculation of PF.
- Spread in area from individual fits is used as uncertainty in fit method.

Isolating elastic peak using fits



- Above is just an example of several fits for elastic production runs on material 20.
- 32 elastic production runs for material 20 are used in analysis.
- Integrated spread in elastic peak areas from all 32 runs used as uncertainty in fit.

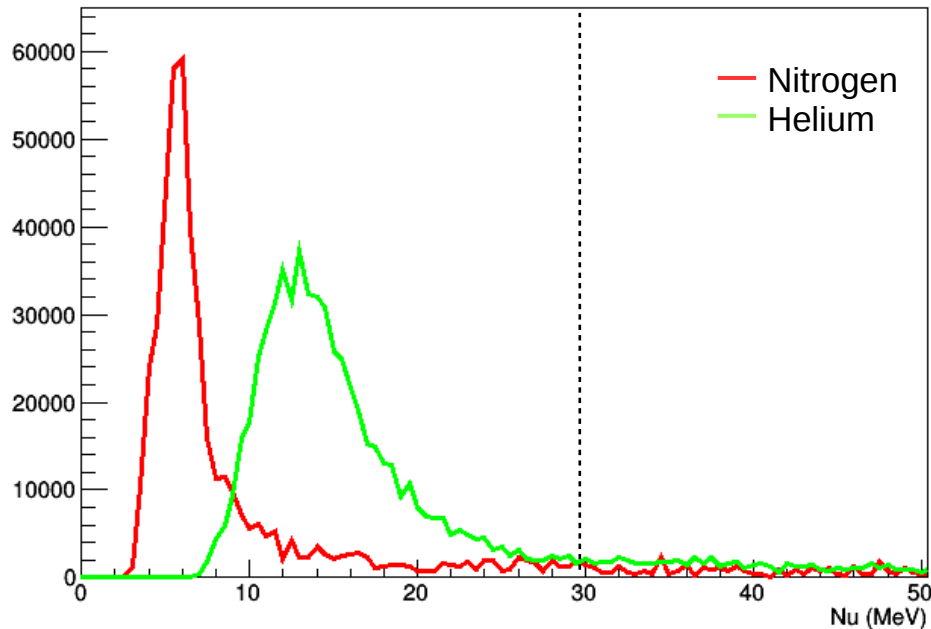
Isolating elastic peak using fits



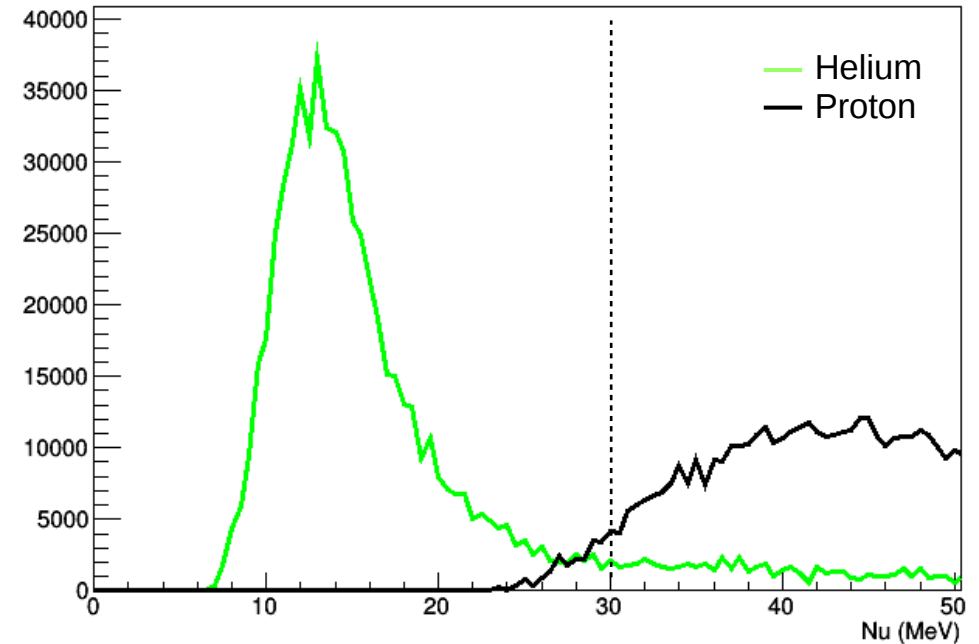
Average area (material 20) is 98296.4 ± 8089.8 (8.23%)

G2psim output and uncertainty

Elastic Simulated XS (g2psim)



Elastic Simulated XS (g2psim)



- Elastic XS integrated from 0-30 MeV (chosen to ensure both He and N entire elastic peaks included in integration while minimizing proton contribution to result).
- Uncertainty in model ratios from two sources:
 - Effect of model ratio by spread in beam position, p_0 , beam energy and raster size inputs (considered because all production runs are averaged for final result). **1.3% for material 20**
 - Uncertainty in model itself. **3%-5%?**

Results

Material 20:

$$Pf = 0.645 \pm 0.0084 \text{ (simulation inputs)} \pm 0.0323 \text{ (simulation)} \pm 0.0531 \text{ (fit method)}$$

$$\mathbf{Pf = 0.645 \pm 0.0937 (14.53\%)}$$

Material 19:

$$Pf = 0.611 \pm 0.0092 \text{ (simulation inputs)} \pm 0.0306 \text{ (simulation)} \pm 0.0503 \text{ (fit method)}$$

$$\mathbf{Pf = 0.611 \pm 0.0900 (14.73\%)}$$

To Do:

- Melissa quoted 0.1mm target length uncertainty (0.35%) in the PF tech note, is this a good final value? (not sure where it came from)
- Finish the rest of the materials/settings.
- Suggestions?