Packing Fraction update
09/13/16

Method (reminder)

$$Y_{production} = Y_{He}^{outside} + (1 - pf)\, Y_{He}^{inside} + pf Y_{NH3}$$

$$Y_{dummy} = Y_{He}^{outside} + Y_{He}^{inside}$$

Production and dilution run yields in terms of materials

$$Y_x \propto \frac{\rho_x L_x}{M_x} \sigma_x$$

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

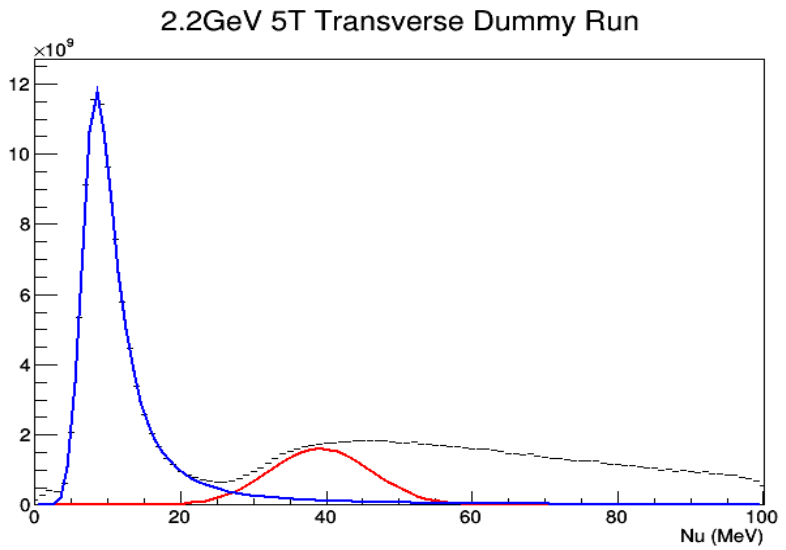
Integrated elastic peak from data

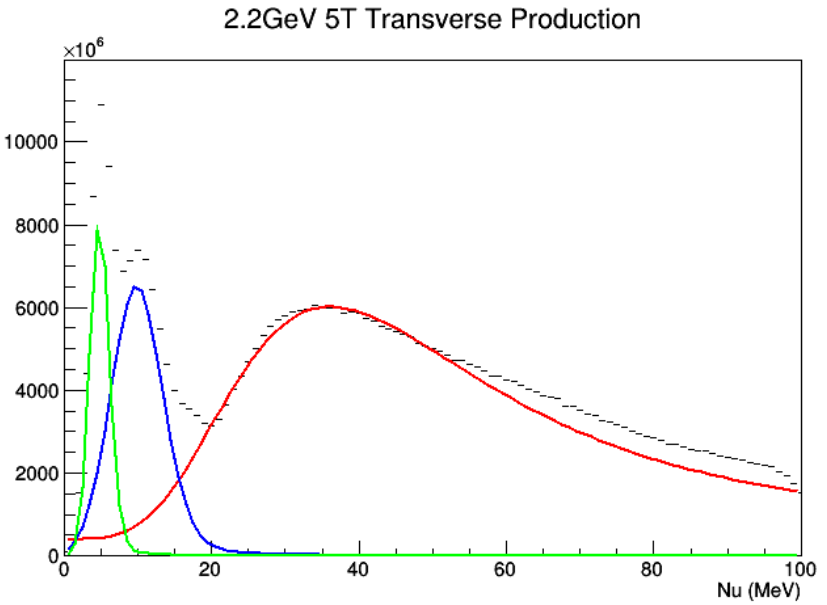
Integrated elastic peak ratios from simulation

Difficulty lies in isolating the elastic peak in data...

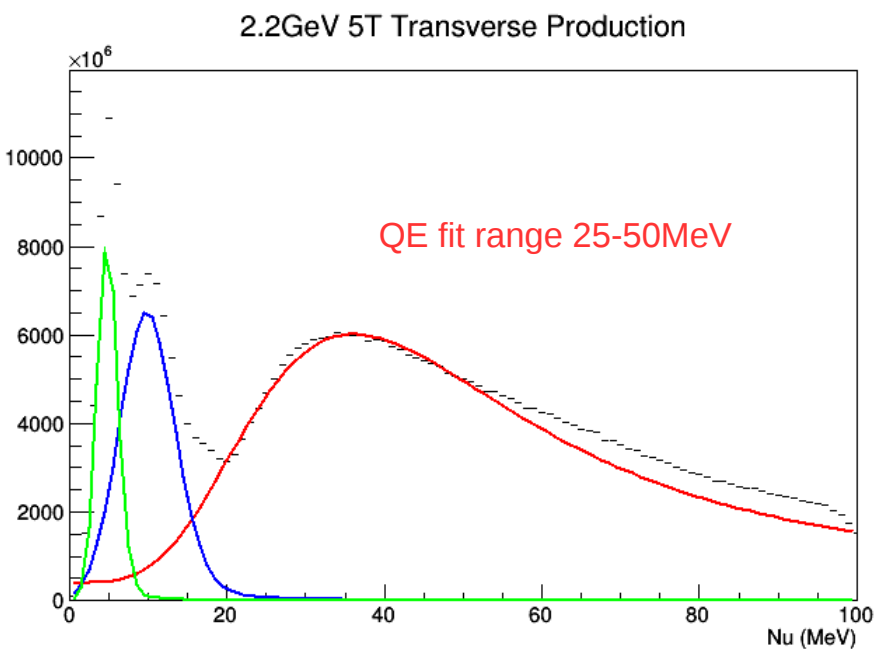
Isolating Elastic Peak using fits

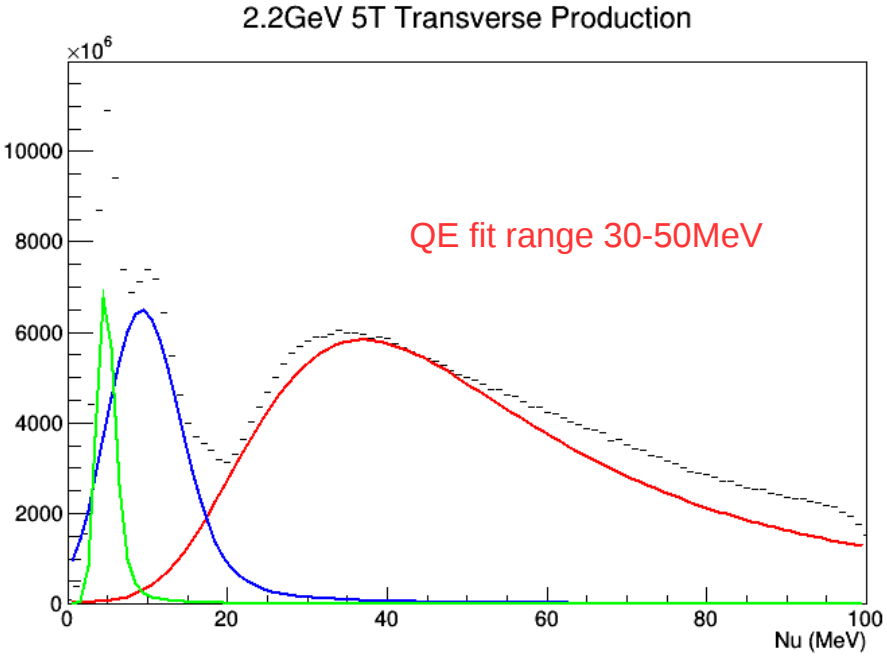
- Fit standard functions to each channel
- Gaussian/Landau convolution fit to elastic peaks, gaussian fit to QE peaks.
- Fit parameters from Dummy run elastic peak used as starting parameters for helium peak in produciton.
- *Resulting fit remains relatively unchanged when using dummy run parameters.*
- Fits extremely sensitive to chosen range.





Isolating Elastic Peak using fits





- The above two fits have the same total reduced chi-sq.
- Any change in fit range drastically changes result, which can affect the resulting PF by huge amounts.
- Too many fit parameters, not enough data points!!

Isolating Elastic Peak using XS models

Procedure:

- Generate Nitrogen and Helium inelastic XS models using P.Bosted in the range 0 to 100 MeV
- Scale the XS models as follows:

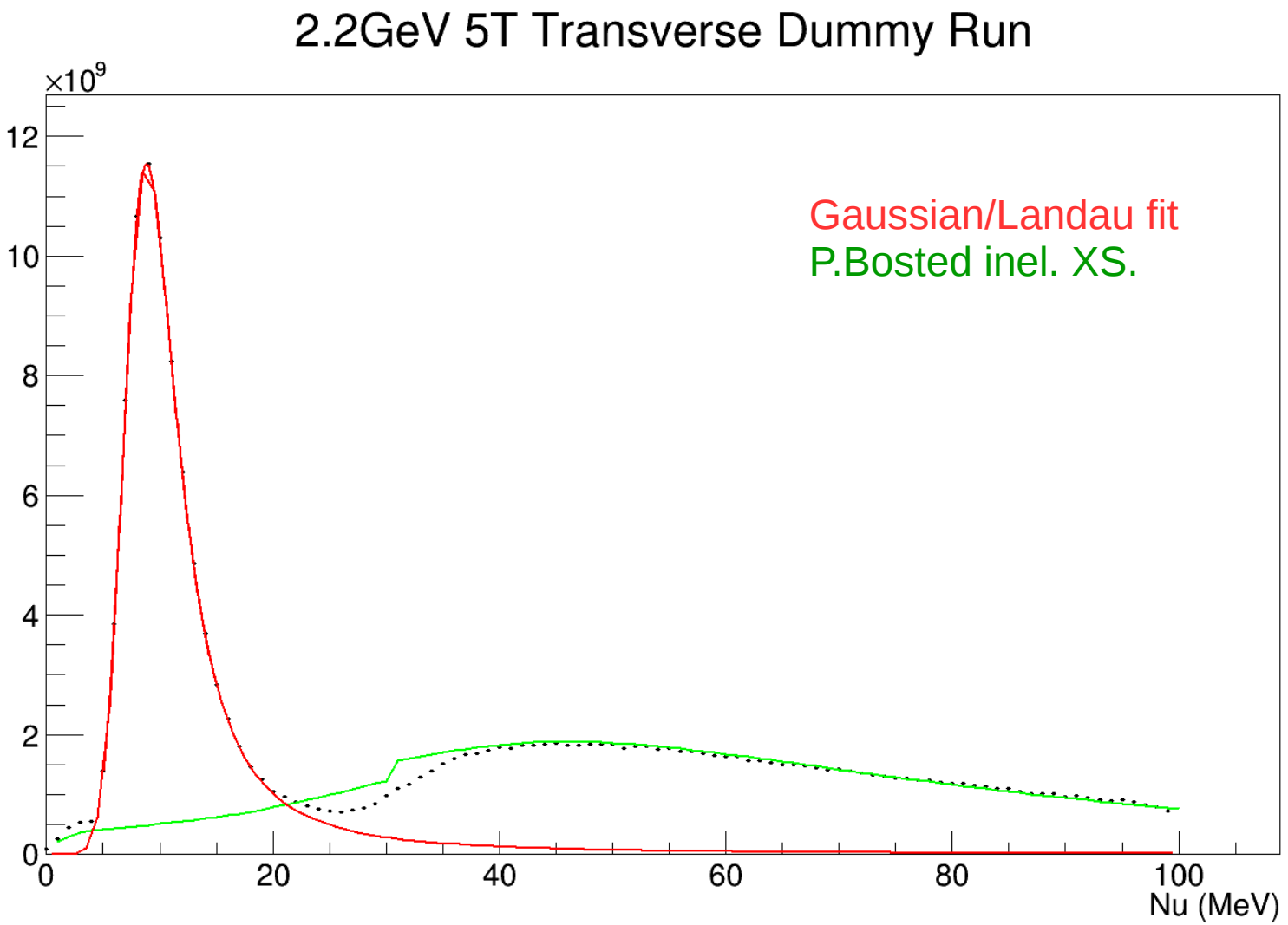
$$Y_N = A \frac{N_o}{e} \frac{\rho_N}{M_N} L_{tg} PF \, \sigma_{N,PBosted}$$

$$Y_{He} = A \frac{N_o}{e} \frac{\rho_{He}}{M_{He}} \left(L_{tg} \left(1 - PF \right) + L_{out} \right) \sigma_{He,PBosted}$$

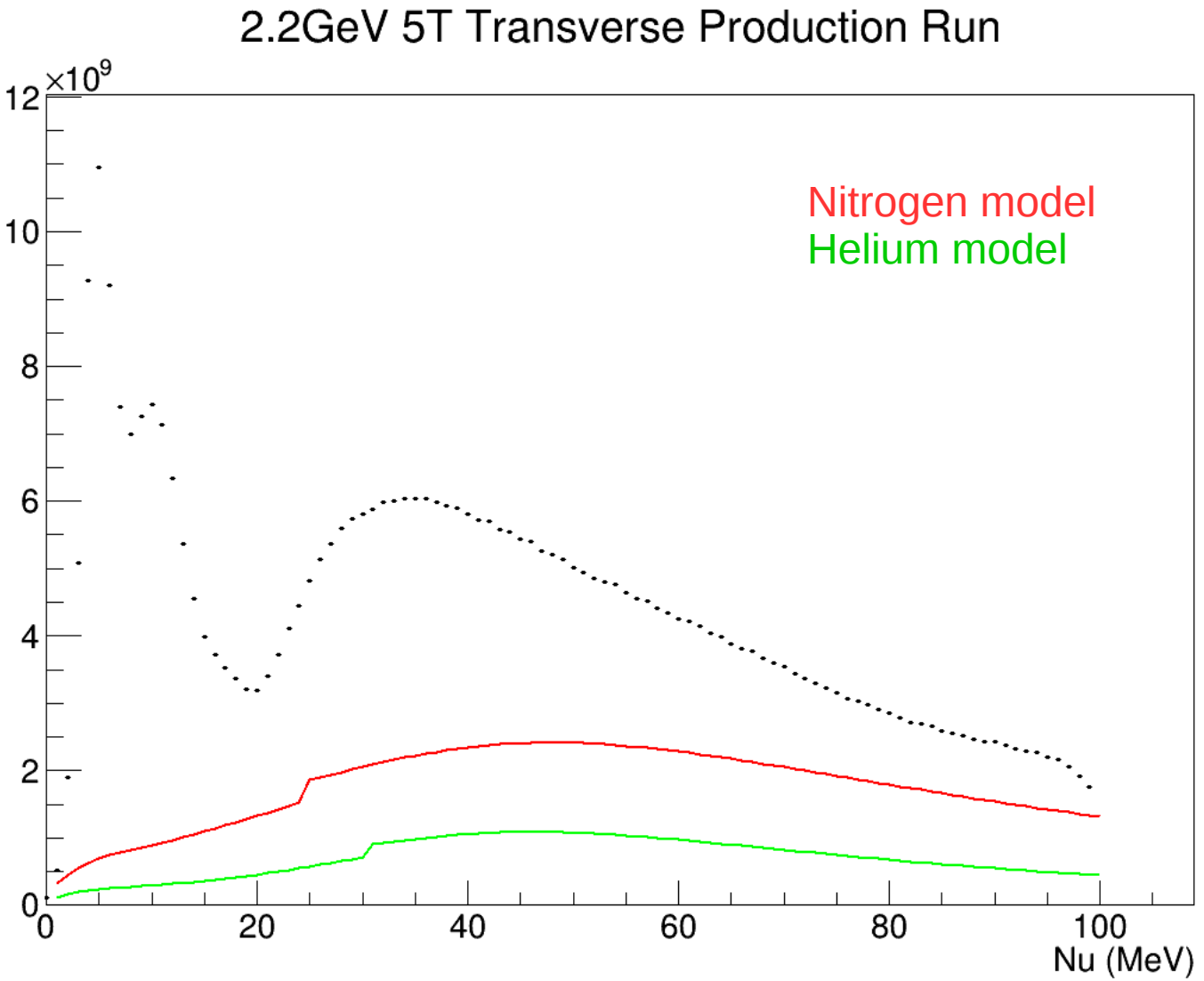
A: acceptance
N_o, e: constants
ρ_N, M_N: target density, mass
L_{tg}: cell length
PF: packing fraction

- Acceptance can be approximated using the dummy run:

$$Y_{He,Dummy} = A \frac{N_o}{e} \frac{\rho_{He}}{M_{He}} \left(L_{tg} + L_{out} \right) \sigma_{He,PBosted}$$



- Gaussian/Landau convolution fit to elastic peak (RED)
  - *This is only used to convince myself that there is no elastic contribution at large Nu (>~70MeV)*
- Scale P.Bosted inelastic XS at large Nu (>~70MeV) to find acceptance. (GREEN)
- **A = 0.00238** (systematic study in progress, but PF is relatively insensitive to small changes in A!!)



- Subtract N14 and He4 models from data
- Integrate elastic peak from 0 to 20 MeV, this ensures minimal proton elastic contamination (a few percent at most, will go into the systematic)

PF calculation

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

- The only thing that remains is the N-He and H-He elastic cross section ratios.
- Melissa's ratio values (from tech note):

Run #	Material	Y_{prod}/Y_{dummy}	σ_N/σ_{He}
5943	20	1.336	1.144
5944	19	1.317	1.118
5945	19	1.333	1.083
5946	19	1.353	1.111
6033	20	1.351	1.090
6034	19	1.345	1.105
6061	20	1.351	1.118
6063	19	1.325	1.134
6081	19	1.342	1.112

- I get a ratio of about ~1.01 using g2psim. Will need to talk to Melissa as the result is pretty sensitive to this ratio.

PF calculation

2.2GeV 5T Transverse PF Results

Run	Material	PF (Melissa's note)	PF (Current method using ratios from Melissa's note)	PF (Current method)
5943	20	0.552	0.521	0.636
5944	19	0.565	0.511	0.602
5945	19	0.660	0.557	0.625
5946	19	0.684	0.562	0.655
6033	20	0.633	0.578	0.654
6034	19	0.655	0.553	0.639
6061	20	0.600	0.518	0.610
6063	19	0.479	0.501	0.603
6081	19	0.587	0.548	0.641

Average (Spread)
(spread relative to average)

19	0.582 (35.2%)	0.532 (11.5%)	0.629 (8.4%)
20	0.593 (13.7%)	0.548 (10.9%)	0.632 (7.0%)

To do:

- Systematic study
  - XS ratio
  - Acceptance determination
  - Bosted model (including scattering angle)
  - Other systematics?
- Get in touch with Melissa about N/He, H/He ratios to see if I’m overlooking something
- Perform same analysis at other settings.
- Tech note with new method?
- Suggestions?