Analysis Updates

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g_2^p Collaboration Meeting
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Overview

- Completed work:
  - PID detector calibrations (gas Cherenkov and lead glass calorimeters)
  - Detector efficiency studies
  - PID cut optimization and cut efficiency studies
  - Data quality checks for PID quantities
  - Preliminary asymmetries

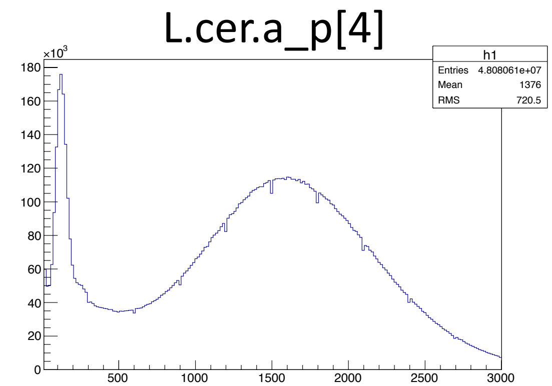
- In Progress
  - Packing Fraction
  - $P_b P_t$ Check

Cherenkov Calibration

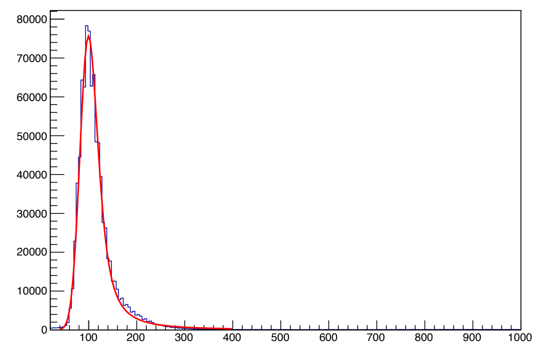
- For analysis, 10 channels are summed together
  - Cut is placed on the final distribution to distinguish between electrons and pions

- First, software gain is adjusted to align the single photoelectron peak in each of the 10 channels

- Peaks are isolated with a series of cuts, then fit with a Landau-Gaussian convolution fit



Pedestal subtracted ADC spectra for Channel 4



Isolated single photo-electron peak

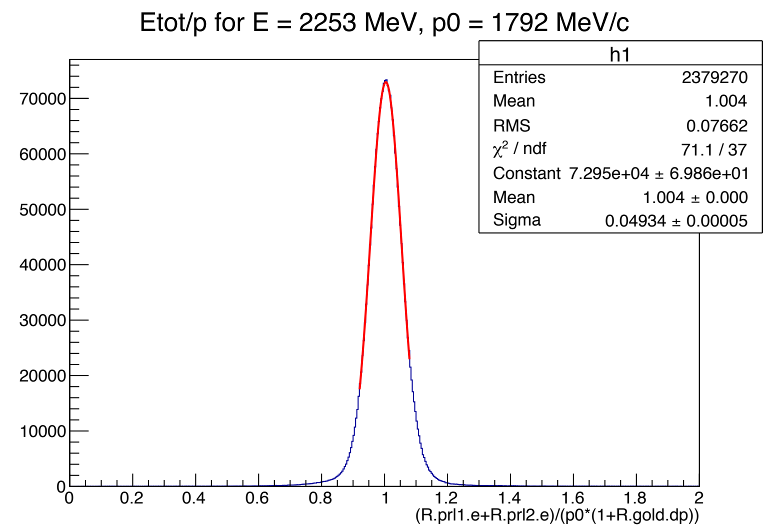
PreShower/Shower Calibration

- Good electron sample is selected for calibration
- Fumili minimization procedure to determine calibration constants

$$\chi^2 = \sum_i^n [\sum C_j(A_j^i - P_j) + \sum C_k(A_k^i - P_k) - P_{kin}^i]^2$$

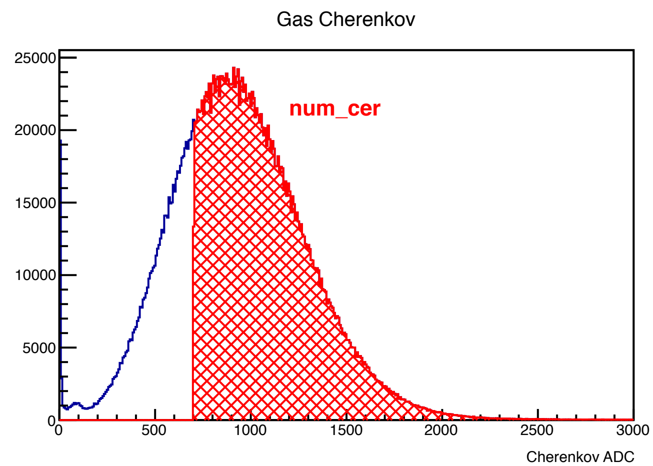
i = event #
j (k) = # of preshower (shower) block included in the cluster for the i^{th} event
A_j^i (A_k^i) = Amplitude value in the j^{th} (k^{th}) preshower (shower) block
P_j (P_k) = Pedestal value of the j^{th} (k^{th}) preshower (shower) block
C_j (C_k) = Calibration constants for the preshower (shower)

- Quality of calibration is checked by plotting E_{tot}/p
- Width of peak gives resolution

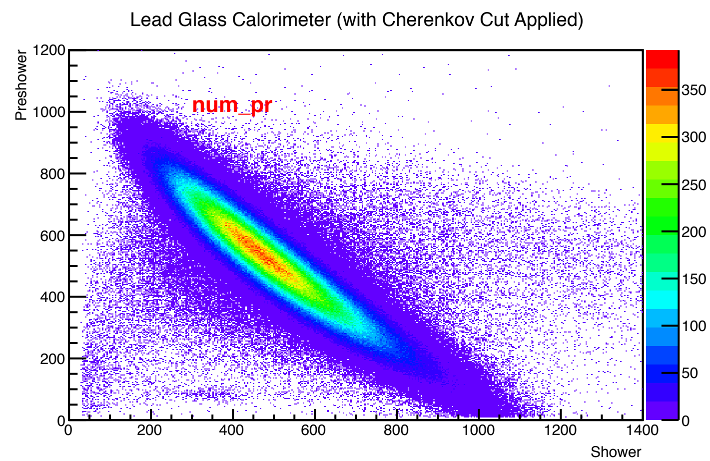


Detector Efficiencies

- Example: to determine efficiency of lead glass calorimeters:



Selection of events that triggered the gas Cherenkov



Events from this selection that *also* trigger the preshower/ shower

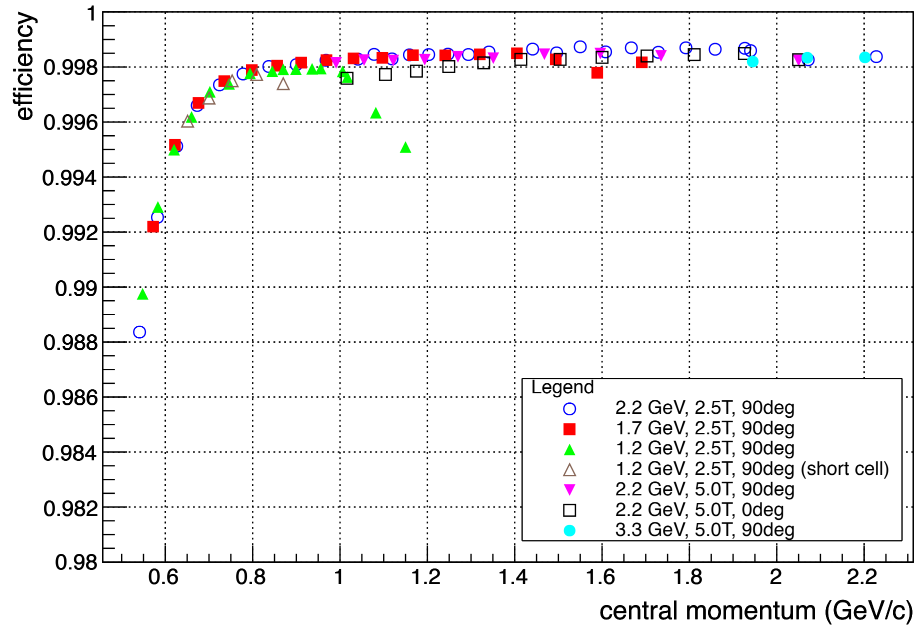
$$num_{cer} = \#\text{ of events selected in gas Cherenkov}$$

$$num_{pr} = \#\text{ of events also detected in Lead Glass}$$

$$\text{efficiency} = \frac{num_{pr}}{num_{cer}}$$

Detector Efficiencies

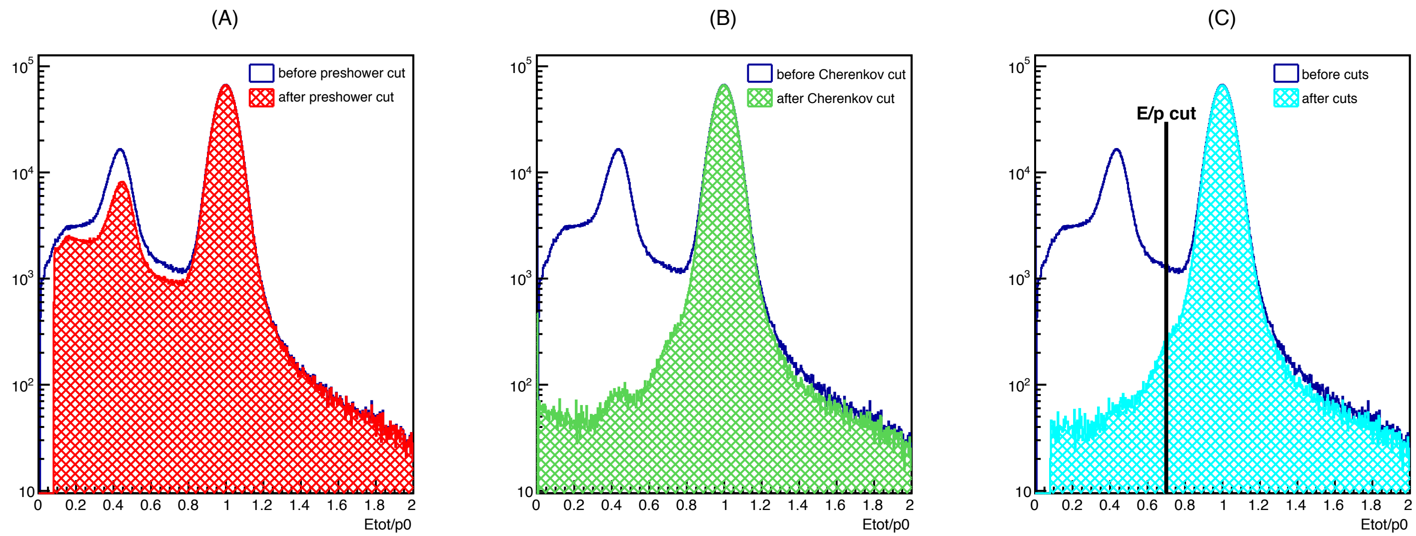
- Indicator of the detector performance throughout the experiment



- High efficiency seen in gas Cherenkov and lead glass calorimeters
  - Gas Cherenkov: >99.8% for both left and right HRS
  - Lead Glass: > 98% for LHRS and > 98.8% for RHRS

Particle Identification Cuts

- 3 cuts applied for particle identification:



Cut on first layer of lead glass

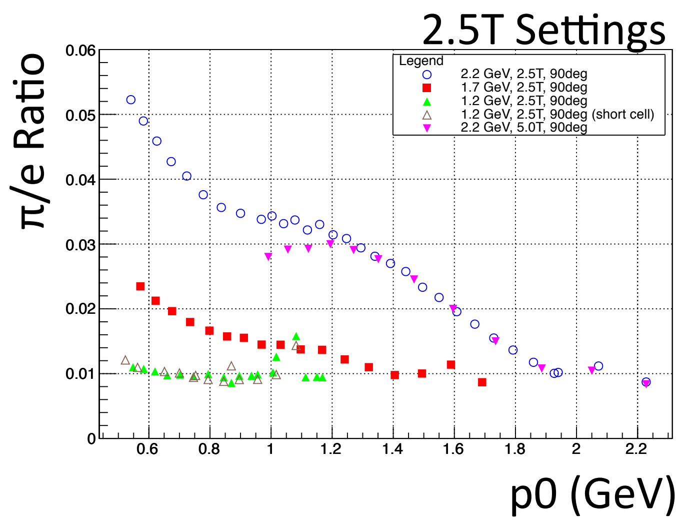
Threshold cut on Cherenkov

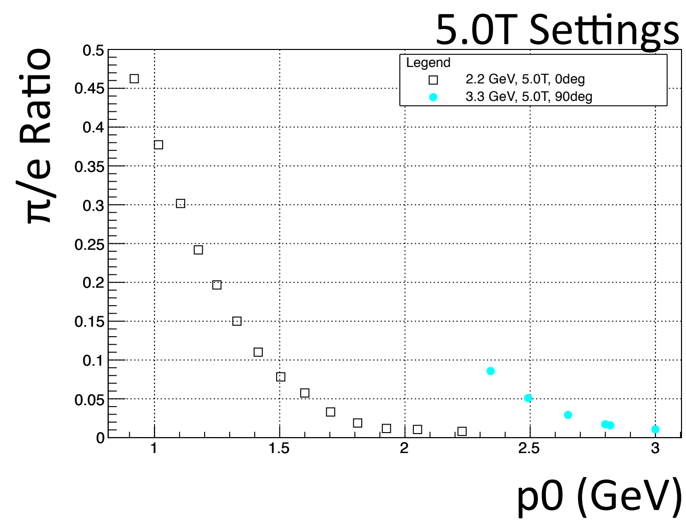
Cut on total energy deposited in the calorimeter

- Cuts are chosen to maximize pion suppression, and minimize the inefficiency caused by cutting out good events
  - Cuts were selected to maintain an overall detection efficiency of ~99%

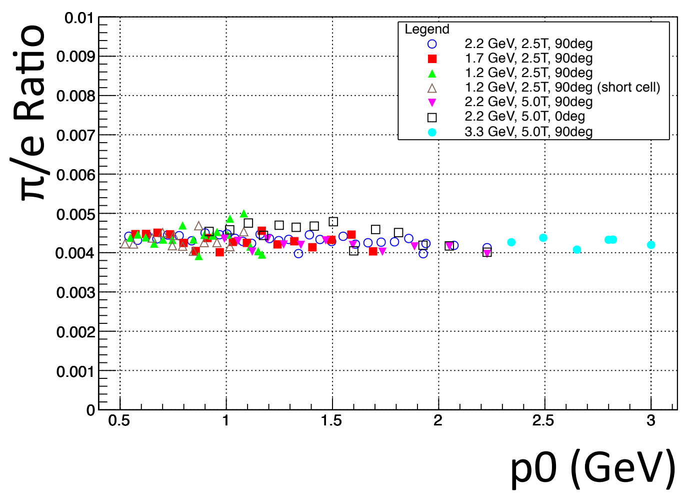
Pion Suppression

Pion Contamination (before cuts)





Pion Contamination (after cuts)

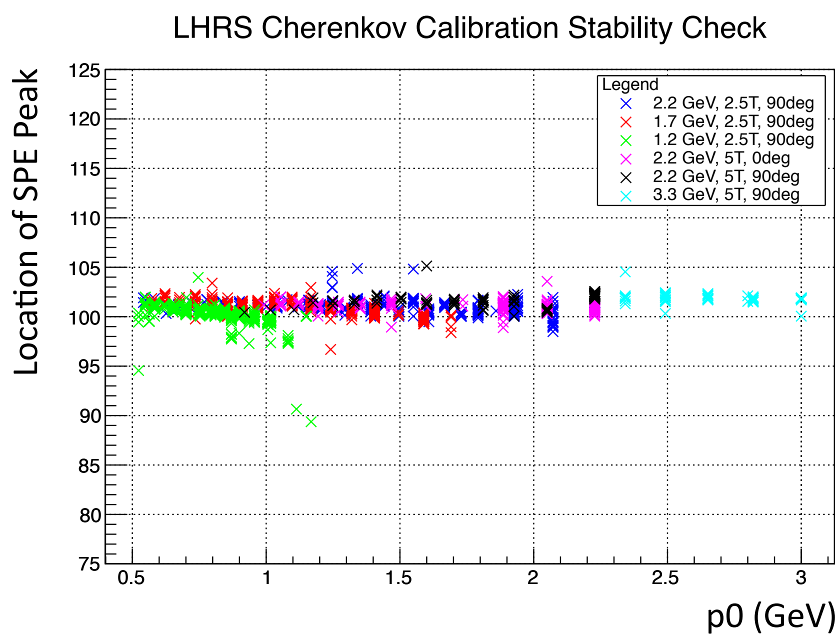


Low residual pion contamination:
$\pi/e < 0.0052$
for all kinematic settings

Details are available in technote: *"Efficiency Studies and PID Cut Optimization"*

Data Quality Checks

- Looked at relevant PID variables
- Example: Gas Cherenkov calibration stability check

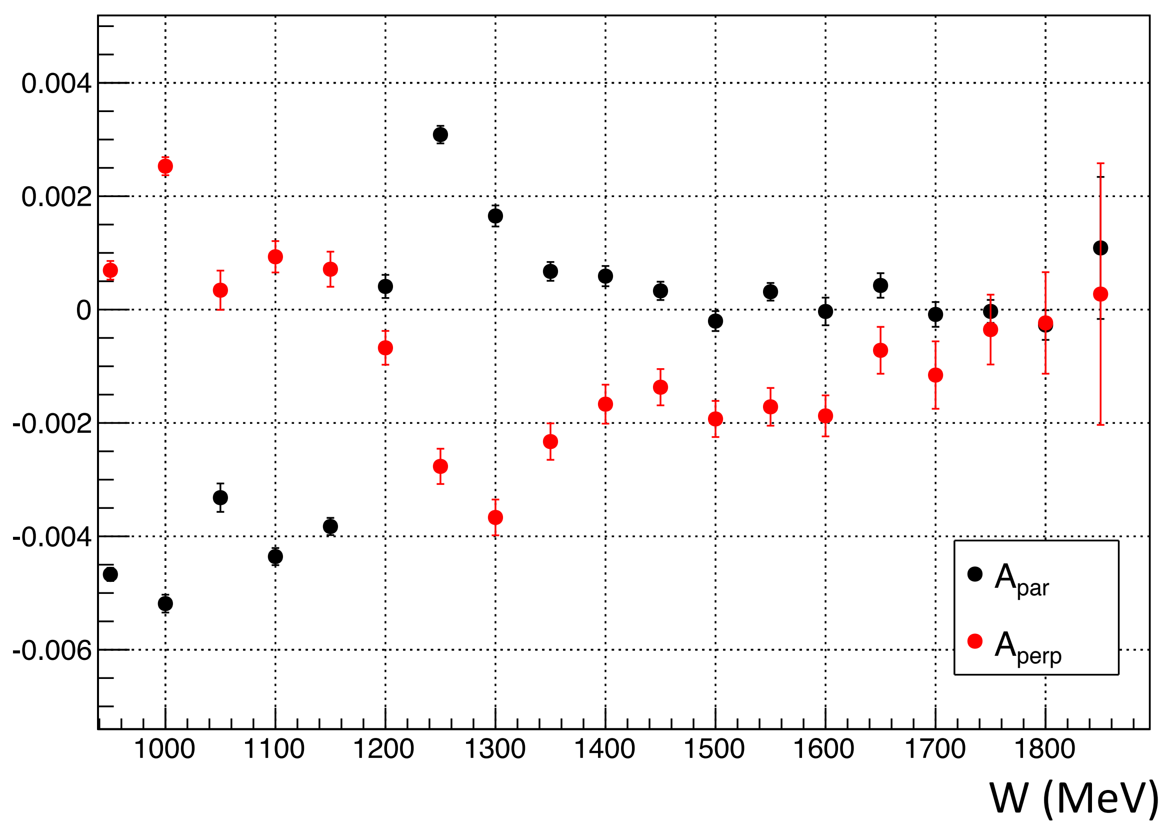


- Details are included in technote: *"Summary of Data Quality Checks for PID Detectors for E08-027"*
  - Includes a table of "questionable" runs

Preliminary Asymmetries

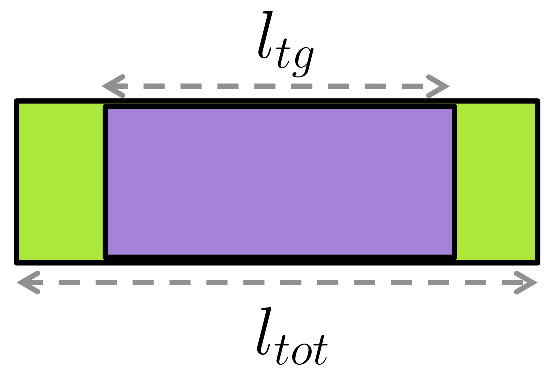
- Example for 5T (longitudinal and transverse) settings shown below (Dilution factor set to 1)

Phys Asymmetries, E = 2.2 GeV, 5T Target Field



Packing Fraction - Method

$$Y_{prod} = Y_{He}^{out} + (1 - p_f) Y_{He}^{in} + p_f Y_N + p_f Y_H$$



$$Y_{tg} = Y_{prod} - Y_{He}^{out}$$

Yield from materials within the target cell

$$Y_{He}^{out} = \frac{(l_{tot} - l_{tg})}{l_{tot}} Y_{dummy}$$

$$Y_{He}^{in} = \frac{l_{tg}}{l_{tot}} Y_{dummy}$$

Assumes uniform acceptance throughout

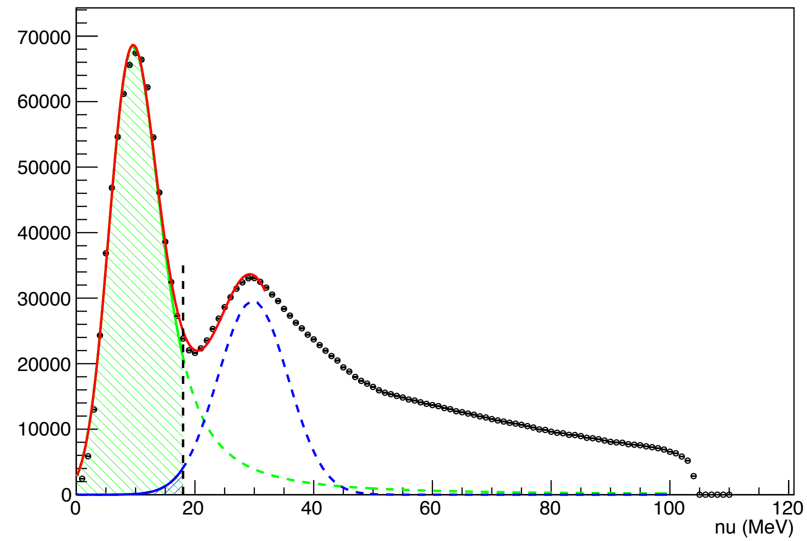
$$(1 - p_f) = \frac{Y_{He}^{in}}{Y_{tg}}$$

Packing Fraction - Method

- Only concerned with elastic peak
  - Fitting routine to obtain level of contamination from QE peaks

- Currently working on:
  - Radiation length matching between production and dummy runs
  - Updating fitting routine to include multiple contributions to second peak
  - Repeat analysis for other materials/energy settings

Fit to Elastic and QE Peaks – Production Run



Current Result:
(2.2 GeV, 2.5T Setting,Material 8)

$p_f = 0.551$

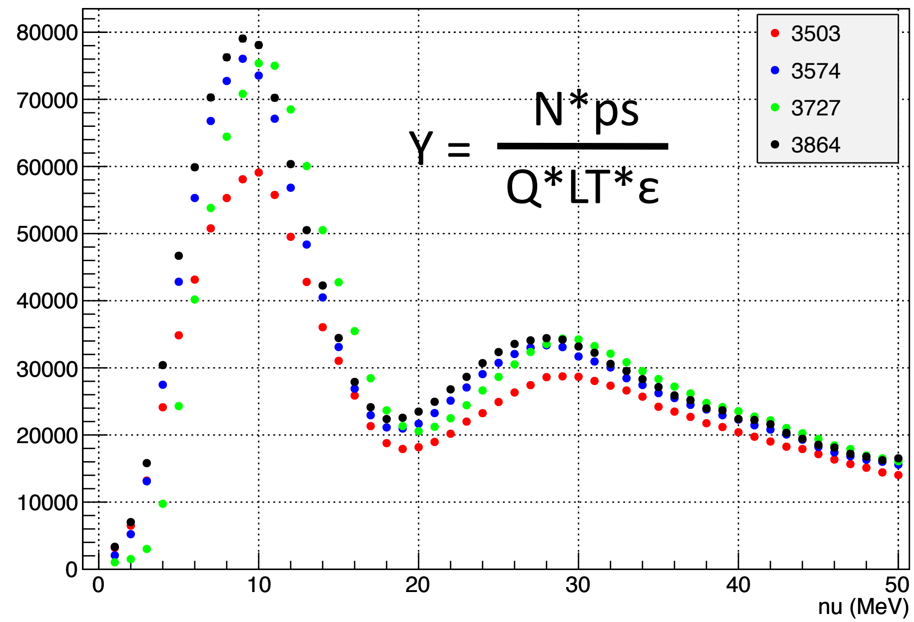
Variation in Yields

- Discrepancy seen in yields for packing fraction runs on the same material

- No correlation seen with:
  - Effect of good electron cuts
  - Helicity gated yields
  - 1st half vs 2nd half of run
  - Including multitrack efficiency
  - Raster cuts
  - Rate/Current

- Still a work in progress

Yields for Packing Fraction Runs
2.2 GeV, 2.5T, Transverse, Material 7



P_bP_t Check using Elastic Asymmetries

$$A \equiv \frac{\nu_z z^* G_M^2 + \nu_x x^* G_E G_M}{(\tau G_M^2 + \epsilon G_E^2)/[\epsilon(1+\tau)]}$$

$$A = \frac{1}{f P_b P_t} A_{exp}$$

Form Factor Parameterization from:

"Relativistic Transverse Images of the Proton Charge and Magnetic Densities", Venkat/Arrington/Miller/Zhan (2010) http://arxiv.org/pdf/1010.3629.pdf

$$\tau = \frac{Q^2}{4M^2}$$

$$\epsilon = \left(1 + 2(1+\tau)\tan^2\frac{\theta}{2}\right)^{-1}$$

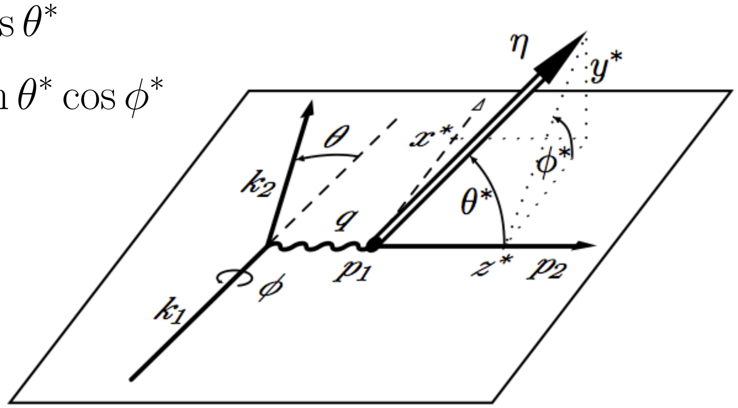
$$\nu_z = -2\tau\tan\frac{\theta}{2}\sqrt{\frac{1}{1+\tau} + \tan^2\frac{\theta}{2}}$$

$$\nu_x = -2\tan\frac{\theta}{2}\sqrt{\frac{\tau}{1+\tau}}$$

spin orientation:

$$z^* = \cos\theta^*$$

$$x^* = \sin\theta^*\cos\phi^*$$



P_bP_t Check using Elastic Asymmetries

$$A \equiv \frac{\nu_z z^* G_M^2 + \nu_x x^* G_E G_M}{(\tau G_M^2 + \epsilon G_E^2)/[\epsilon(1+\tau)]} \qquad A = \frac{1}{f P_b P_t} A_{exp}$$

2.2 GeV, 5T Longitudinal, Material 18:

Average Polarization Values:
P_t = 74.4%
P_b = 82.46%

A_{pred} = -0.0317221

A_{raw} = -0.00954804
↓
f = 0.49

- Still in progress
- Updates:
  - Method to determine scattering angle
  - Include radiative corrections

Timeline for Graduation

- Short term plan:
  - Current analysis projects:
    - Packing fraction – should finish SOON (by the end of the year)
    - P_bP_t check with elastic asymmetries – 1-2 months(?)
- Long term plan:
  - Physics asymmetries with final dilution factor
  - Analysis for thesis topic
- Graduation timeline:
  - Plan to graduate – Spring 2015
  - Post graduation plans - ???
    - Looking into both post-docs and industry jobs